Materials & Methods

Metal Powder Show Preview
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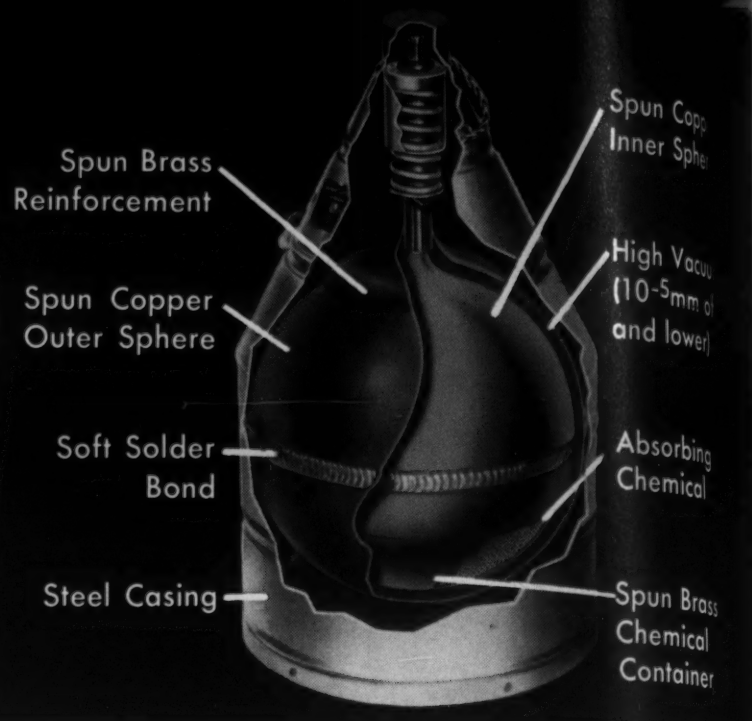
CARBON AND GRAPHITE MATERIALS AND PARTS
—Materials & Methods Manual No. 81

APRIL
1952

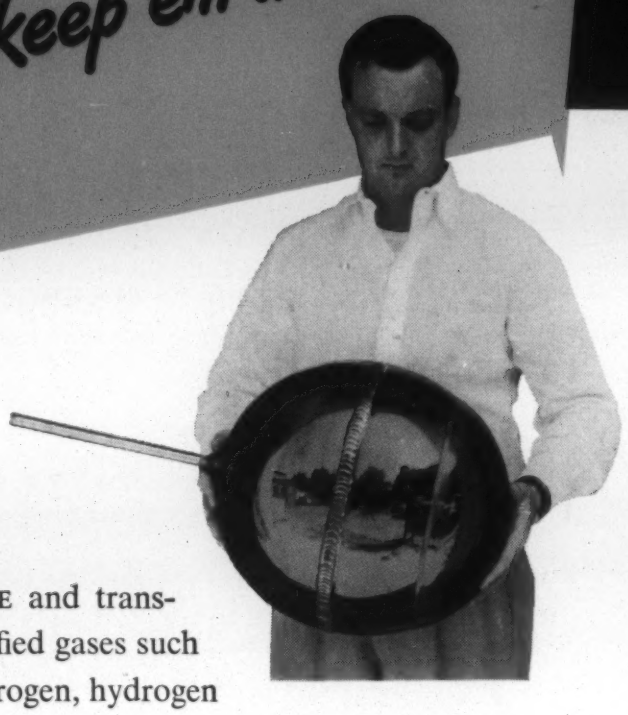
THE MAGAZINE OF
MATERIALS ENGINEERING
DEVOTED TO THE MATERIALS PROBLEMS OF PRODUCT DESIGN AND MANUFACTURE

It's COLD inside these liquid gas containers...

and polished copper helps keep 'em that way



Cutaway section of a Hofman "Standard" Liquefied Gas Container, made in a range of sizes from 5 to 2000-liter capacity.



This is Herb Basewit, design draftsman of Hofman Laboratories, Inc., holding an unretouched polished copper inner shell for a 25-liter container. A perforated spun-brass dish soldered on one end holds a chemical which absorbs any leakage of gas into the vacuum.

Here Herb is seen pointing to the hole for exhausting air to obtain vacuum. A solder bond is used to join the copper hemispheres.

In the storage and transportation of liquefied gases such as air, oxygen, nitrogen, hydrogen and helium, evaporation losses are the big problem (containers can't be sealed because of explosion risks). If insulation is not adequate for the *minus*-452 F temperatures encountered, losses are costly.

Hofman Laboratories, Inc., of Newark, N. J. took a big forward step and made some radical changes in container design. Resembling a giant picnic vacuum bottle, the "Standard" Hofman Container is constructed of an inner and outer copper sphere separated by an extremely high vacuum. Bulky insulation is eliminated and, through the use of polished copper, surface radiation losses are greatly reduced.

Here, as in many other industrial applications, copper does a multi-purpose job better than any other metal by providing: (1) the ductility and malleability necessary for deep-spinning the hemispheres, (2) an unequalled metal for soldering, and (3) a smooth-surface, fine-grain metal that will readily take a mirror-like finish.

Anaconda Metals are made by The American Brass Company, General Offices: Waterbury 20, Conn. 5285

ANACONDA

COPPER and BRASS

The Materials Outlook

"Our major problem in the current year," says the president of Westinghouse, "will be sales, not production." He foresees an end to scarce-buying of critical materials, and says Westinghouse plans an increase in production of consumer durable goods. . . . An easier feeling on metals supplies is spreading. Washington is talking about an extra allotment of copper for automobiles. . . . This will not be like 1949, though. Stockpiling and military purchases will hold up metals consumption regardless of fluctuations in demand for consumer goods. . . . Zinc and tungsten are definitely becoming easier to get. Easier aluminum supply is making several copper manufacturers who were thinking of getting into aluminum hold off.

Aircraft engineers are giving increased attention to the 17-7PH and 17-4PH chromium-nickel precipitation hardening stainless steels. These grades solve many of the problems encountered with standard hardenable chromium stainless and standard chromium-nickel stainlesses. The precipitation hardening steels contain copper or aluminum and are heat treated at 850 to 1400 F. These low temperatures prevent scaling, decarburization, cracking and warping. Welds are ductile, and severe hot and cold working can be accomplished.

Elgin National Watch Co. has developed a new alloy for escape wheels for jeweled watches. It contains 20% nickel, and combines wear resistance and corrosion resistance. . . . Hardened steel has traditionally been used in escape wheels in quality watches. The new alloy's strength, corrosion resistance and anti-friction finish make it superior to steels, according to Elgin.

A British engineer, Dr. E. C. B. Corlett, points out that 15 to 20% of the original weight of the new American liner "United States" was saved by using aluminum in place of steel extensively. While the initial material costs went up, reductions in the hull and machinery costs cut the total price of the ship by an estimated $1,000,000. The fuel saving amounts to 8 or 9%, or about $250,000 per year. . . . No expansion joints are used in the 500-ft long superstructure. It is doubtful if the ship could have been built without aluminum, in view of the rigid beam limitation, three-compartment flooding and damaged stability requirements.

New formulas for lacquer thinners, now applied in General Motors' automotive divisions, have improved the technique and the results of applying

(Continued on page 4)

The Materials Outlook *(continued)*

lacquer to car bodies. . . . The new formulation eliminated the tendency of the finish to orange peel. It improves surface smoothness, requires less polishing and fewer coats of lacquer to build up a specified film thickness. . . . Most of the desirable results of hot lacquer are obtained, with fewer complications.

Navy research on the shock resistance of materials indicates that differences arising from chemical composition in aluminum can be obscured by variations in melting and casting procedures. As-cast test sections proved superior to machined test sections. The harmful effects of porosity are determined by the shape of the voids and the ductility of the material -- shock resistance is greater with spherical voids and more ductile metals.

A recently announced forming method for glass takes advantage of a special photosensitive composition. The glass is covered with a cut-out pattern and exposed to ultraviolet light. When the glass is heat treated, a milky image appears corresponding to the pattern. This image is 50 times as soluble in hydrofluoric acid as the clear portion. Immersion in a dilute solution of the acid eats away the pattern image, leaving the shape desired. Surface patterns or solid shapes can be made.

A new process for nickel coating aluminum has been developed by Hamilton Standard Div., United Aircraft Corp. and the Bart Laboratories. A synthetic rubber compound establishes the bond. The major application is protecting duralumin propellers from pitting and eroding in sea landings and takeoffs.

Successful welding of heavy thicknesses of pure copper is reported by Linde Air Products Co. Test welds made with the company's equipment for sigma welding are said to be sound, with good contour, surface appearance and penetration.

Auto makers and manufacturers of refrigerators, stoves and other consumer durable goods can expect to get only small slices of the aluminum which the Air Force cannot use in the second quarter. Just how much aluminum will be made available is not known, but indications are that it will be in excess of 20 million lb.

New laminating resin which will withstand temperatures up to 500 F has been announced by U. S. Rubber. New resin has physical and handling properties similar to other polysters, but has greater heat resistance. It is now being tested for use in high-speed aircraft and guided missiles.

See page 6 for "Materials Control Orders"

for **Heat-Resisting Applications**

INCOLOY

1. 32 Nickel—21 Chromium.
2. Resistance to oxidation.
3. Resistance to moderate sulfidation.
4. Freedom from sigma embrittlement.
5. Strength at high temperatures.
6. Good workability.
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Incoloy® is the newest member of the Inco High-Temperature Alloy family. It was developed as a companion to Inconel® and is permissible for use in applications described in NPA Order M-80, Schedule C.

Like the other INCO Nickel Alloys, Incoloy is on extended delivery because of defense demands. So it will pay you to anticipate your needs well in advance. When ordering, be sure to give NPA rating and complete end-use information.

When you want assistance on heat-resisting uses, Inco's High-Temperature Engineering Service is always ready to help you. Write for a High-Temperature Work Sheet on which you can outline your problem for their attention.

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Materials Control Orders

A summary highlighting actions of the NPA affecting engineering materials during the period from Feb. 11, 1952 through Mar. 10, 1952.

● **CONTROLLED MATERIALS PLAN**

Under agreement with the NPA, manufacturers of portable electric and pneumatic tools can request increasing allotments of aluminum on a supplementary CMP 4B application form if the MRO orders are for military requirements.

Anticipated Changes: Reg. 1—Decontrol of non-nickel-bearing clad steel and non-nickel-bearing stainless steel is under study by the NPA.

Reg. 6—Under a proposed amendment a new rating, Z-3, would be substituted for the present U-4 rating for securing machine tools. Machine tool builders would not be permitted to ship on the basis of U-4 unless it had been converted to a Z-3 rating. Unconverted orders would become unrated after Apr. 15.

● **ALUMINUM (Orders M-5, M-67)**

Anticipated Changes: Manufacturers will be permitted to accept orders up to 125% of productive capacity; fabricators will be permitted to sell up to 5% of their available supply of metal on unrated orders under an amendment to order M-5, now being considered. Proposed amendments to M-67, which regulates the use of aluminum foil, would combine two product classifications; provide a system to give preferential treatment in filling orders; permit shifting of aluminum foil from one classification to another to meet seasonal fluctuations; make foil, intended for locker plant use, subject to this order with the objective of permitting such plants to purchase the foil as a class "B" product instead of as a controlled material requiring a CMP ticket.

● **CADMIUM (Order M-19)**

Anticipated Changes: A proposed revision of this order would permit unlimited use of cadmium to fill direct defense requirements in the "A" through "E" and "Z-2" categories; permit unrestricted use of cadmium in the production of all items now on the "permitted use" list of the present order; allow consumers to use up to 70% of the cadmium consumed during the first half of 1950 for all other purposes.

● **COBALT**

NPA suggested that all orders involving the use of more than 10 lb be listed individually, while orders requiring lesser quantities should be basketed on an end-product basis.

● **COPPER (Orders M-82, M-86)**

An amendment to M-82 permits distributors of brass mill products to sell materials from stock only to fill ACM orders, excepting that quantities of 25 lb or less can be sold without such an order. The order also permits distributors to purchase from other distributors and to sell up to 10,000 lb of condenser tubes on any one ACM order without written approval from NPA. Under order M-86 as amended, distributors are permitted to sell copper wire mill products only on authorized ACM orders. However, up to 10% of a "standard package" can be sold to one customer without such an order.

● **IRON AND STEEL (Orders M-6A, M-59, M-80)**

An amendment to M-6A provides that aircraft quality alloy steel products can be used in gas turbine engines or aircraft-type internal combustion engines for naval vessels. Another amendment to the same order redefines alloy steel, stainless steel, nickel-bearing stainless steel and carbon steel to conform with the definitions in basic order M-1; designates corrugating and forming of iron and steel roofing and siding, ridge roll, valley and flashing by steel distributors as a ware-house operation; sets certain limits on the replacing of inventory of reinforcing bars.

Anticipated Changes: Revocation of steel strapping order M-59 is under consideration, but the 45-day inventory limitation will remain in effect. An amendment to M-80 is being considered to clarify the permanent magnet industry's conservation problems. Tool steel may be segregated as a "steel product" in the carbon and alloy steel product list in time to be identified for fourth-quarter 1952 allotments.

● **LEAD (Orders M-24, M-38, M-93)**

An amendment to order M-24 established three new classifications: "unmended menders", "unassorted temper tin plate" and "other coated secondaries"; permits the use of waste—waste for items not prohibited in schedule B; permits use of tin or terne plate coated with less than the maximum permissible coating for certain schedule A products. All restrictions on the use of lead under order M-38 are removed and inventory restrictions are relaxed to permit a 60-day inventory. However, the reporting features of M-38 are retained. Because of the increasing availability of lead, order M-93, which limited the production of electric storage batteries, has been revoked.

● **POLYETHYLENE (Order M-45)**

Anticipated Changes: In view of increased supplies, polyethylene may be removed from control by the end of the third quarter of 1952.

● **POLYTETRAFLUORETHYLENE (Order M-45)**

Polytetrafluorethylene ("Teflon") has been removed from control since supplies are adequate to meet military and civilian needs.

● **SELENIUM (Order M-91)**

Suppliers are now authorized to deliver selenium on the purchaser's certification that he is entitled to buy and use the material. NPA has taken no action on the proposal to raise the inventory limitation from 30 to 60 days because 30-day inventories are not currently obtainable.

● **TIN (Orders M-24, M-25)**

An amendment to M-24 establishes three new classifications, "unmended menders", "unassorted temper tin plate" and "other coated secondaries"; permits the use of waste—waste for items not prohibited in schedule B; permits the use of tin or terne plate coated with less than the maximum permissible coating for certain schedule A products.

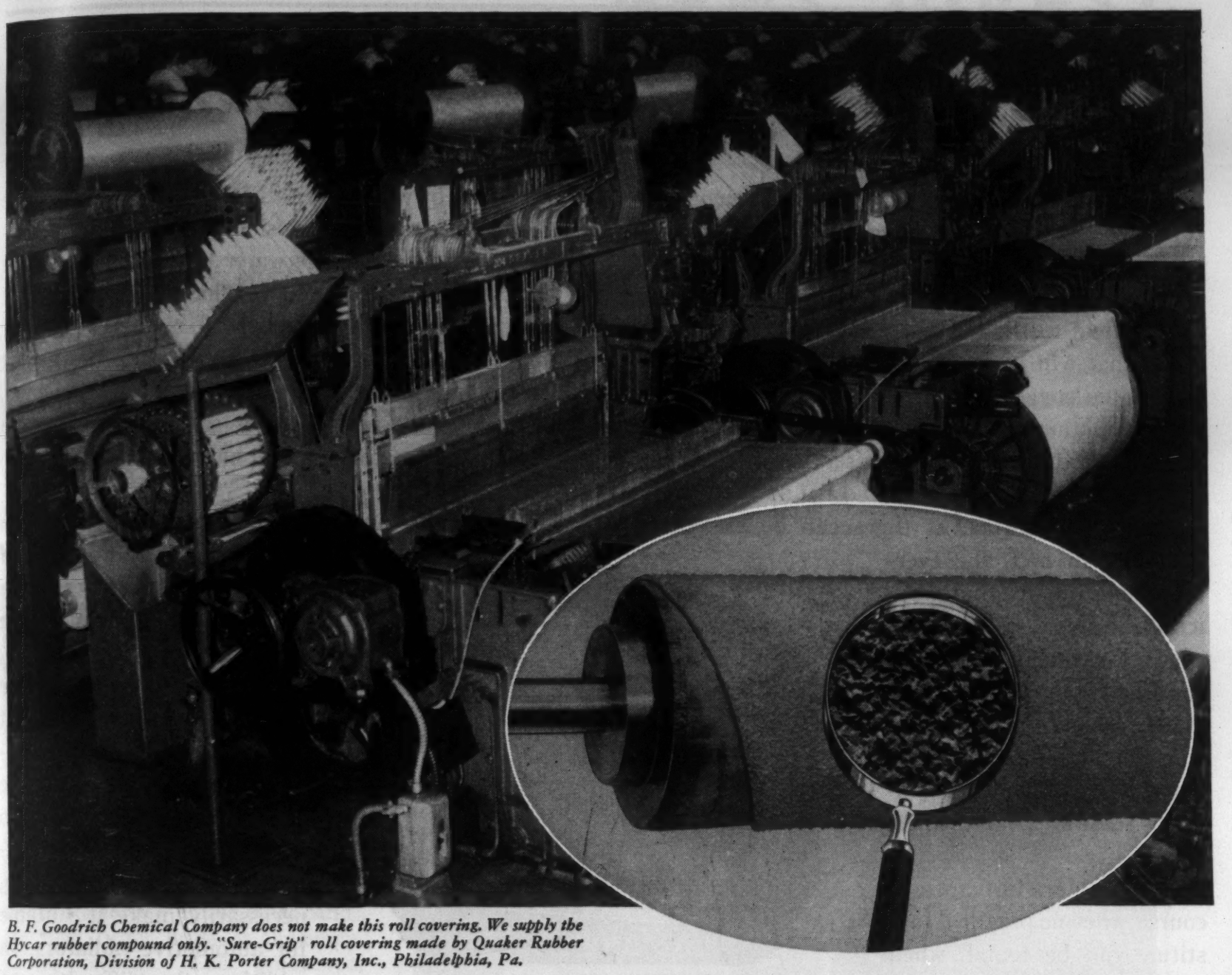
Anticipated Changes: A revision of order M-25 will make 103,000 tons of secondary tin mill products available to can manufacturers without quota restrictions. Elimination of all quota restrictions on the manufacture of items specified in M-25 is under consideration.

● **NPA REGULATIONS**

NPA indicated that consideration is being given to establishing a more uniform inventory policy for the wire and cable industry. The possibility of handling "A" through "E" rated orders on a more equitable basis is also under consideration.

Another development using

B. F. Goodrich Chemical Company *raw materials*



B. F. Goodrich Chemical Company does not make this roll covering. We supply the Hycar rubber compound only. "Sure-Grip" roll covering made by Quaker Rubber Corporation, Division of H. K. Porter Company, Inc., Philadelphia, Pa.

RUBBER SANDPAPER THAT WON'T HARM FINE FABRICS!

IN processing synthetic textiles, some sizing oils attack the rubber covering on take-up rolls and stop production. To overcome this time-and-money loss, a rubber products manufacturer investigated Hycar rubber compounds. See what he found!

First, exactly the kind of superior oil-resistant rubber to do the job. And—the Hycar compound processes much easier than compounds used previously . . . has better abrasion resistance which makes for longer-lived roll coverings.

What Hycar does here is typical of the many ways it helps make important savings and do a *better* job. For Hycar rubber compounds have many advantages—resistance to heat and cold, gas, oil, many chemicals, abrasion and more damaging factors. One of the many Hycar rubber compounds may be just what you need to improve or develop a product. Technical assistance and bulletins are yours for the asking. Write Dept. HQ-2, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco.

B. F. Goodrich Chemical Company
A Division of The B. F. Goodrich Company

Need extreme temperature resistance? Hycar has it—plus abrasion resistance and more advantages.

Hycar
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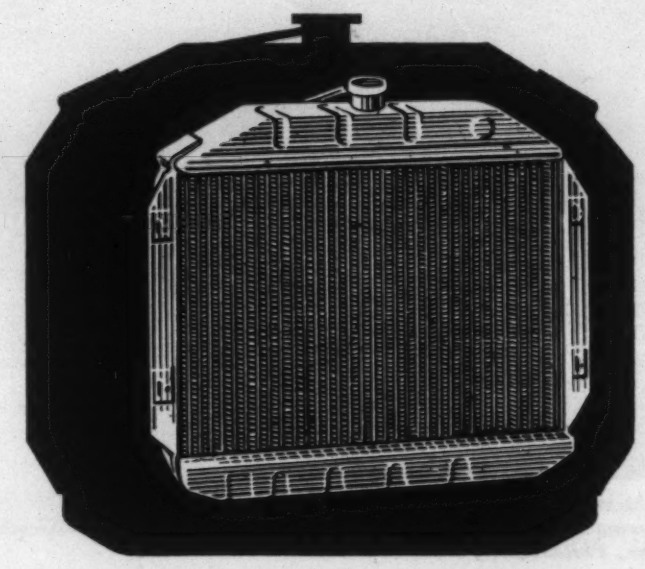
HARMON organic colors

BUSINESS IN MOTION

To our Colleagues in American Business . . .

Substitution of materials is of considerable concern to many manufacturers these days. Never before have we seen so much interest in the subject. However, it is by no means new to Revere, which has always held to the principle of recommending the metal that will best serve the customer. Thus, we have often suggested switching from one metal or alloy to another, with the object of lowering costs, increasing production, improving service, or all three.

When based on a detailed study of all the factors involved, substitution at times can be extremely valuable. In fact, the ever-increasing quality and service to be found in American products is due in part to the continued search for better materials, and their adoption when found. Better materials, better design, finer workmanship—these are part of American progress.



But there are instances, of course, when no practical substitute can be found, when only one material offers just the right combination of good qualities required for a given application. Take the automobile radiator. This has always been made of copper, because copper is the one and thus far only metal that perfectly meets all the requirements of manufacture and service. To make a radiator, very thin copper sheet and strip must be crimped, bent and otherwise formed. Copper's easy workability makes it ideal from the manufacturing standpoint. After assembly, the radiator is cleaned, and made water-tight by dipping in a bath of hot solder. Copper is exceptionally easy to solder. When in service on a car, truck or bus, the radiator must not rust, and must resist corrosion by water and anti-freeze. Copper is notable for its resistance to corrosion in such use. The radiator must also cool the water by radiating its heat into the air stream; copper has the highest heat conductivity of all commercial metals. A copper radiator thus is the most efficient and durable. It should outlast the car unless accidentally damaged, and when the injury is not so great as to make replacement necessary, the nearest shop can make repairs easily.

Recently it has been suggested that automotive radiators should be made of aluminum. However, both copper and aluminum are temporarily in short supply, and therefore to substitute one for the other does not appear to be practical. Beyond that, we do not believe —based upon experience to date—that aluminum's qualities, fine though they are, necessarily make it suitable for automotive radiators. In addition, the difficulties of retooling in the factory and repairs in the field must be considered. Revere fabricates both copper and aluminum, and we have reason to believe that our impartial advice to stay with copper for automotive radiators is concurred in by radiator manufacturers.

When you are tempted to substitute one material for another in your product, no matter what it may be, make certain you obtain all the facts as to costs, production, service. Your suppliers will be glad to collaborate with you in studying the effects of a proposed change. We suggest you take full advantage of their knowledge and experience.

REVERE COPPER AND BRASS INCORPORATED

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Executive Offices: 230 Park Avenue, New York 17, N.Y.

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News Digest

SAE Materials Meeting Covers Aluminum and Magnesium Automobile Applications

The Detroit Meeting of the Society of Automotive Engineers in March included an important session on the applications of aluminum and magnesium. J. H. Dunn and E. P. White, of the Aluminum Co. of America, covered aluminum developments. They discounted all-aluminum automobiles as too expensive, at the present time. A number of specialized applications were noted, however. One present concept is to divide complicated aluminum castings into simple, easy-to-make sections which are assembled by brazing. It is believed possible to produce brazed aluminum parts in this way at a price competitive with cast iron. Another recent development is the use of aluminum die castings for highly stressed parts. A clutch housing is now being die cast. Many parts for torque converters, on the other hand, are now being made as aluminum plaster castings. This production method is gaining in popularity for intricate parts, especially those with back drafts. Highly stressed parts are not considered applicable to plaster casting, however.

The development of an aluminum alloy for automobile radiators was also discussed. The problems here are construction methods and corrosion resistance. Dip brazing seems to have worked out as the best method of making radiators. In alloy selection, 3S is the standard material. This alloy is electrolytically protected with an Alclad coating on one side. The other side is clad with C43S brazing alloy. Test work to date indicates that corrosion is not critical with this material.

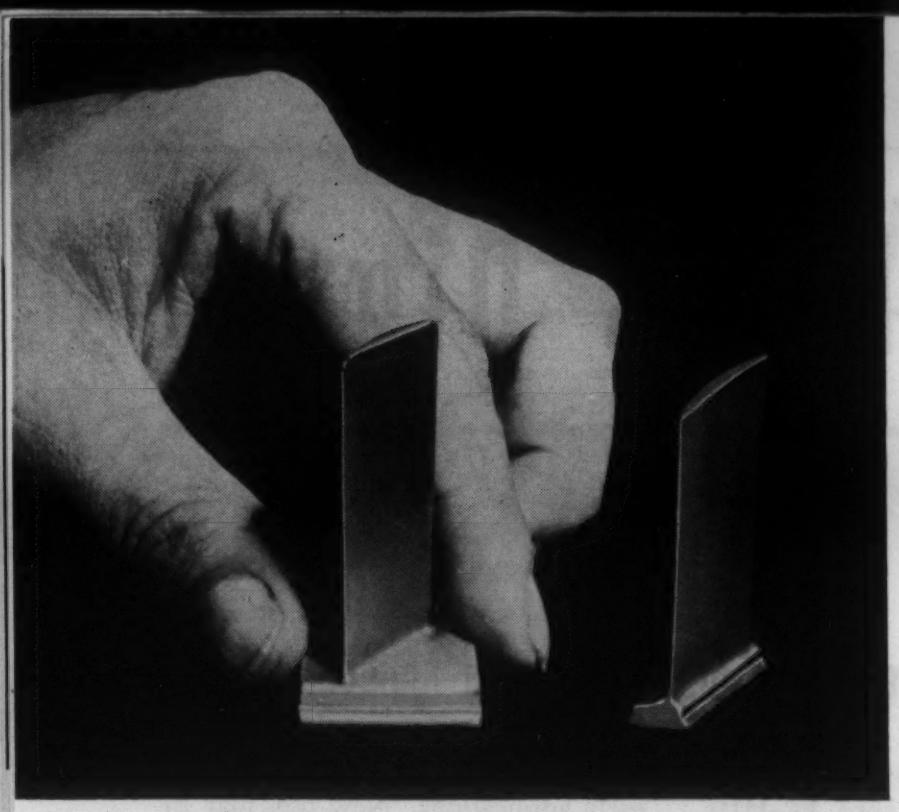
Aluminum is also being investigated for automotive wiring. The problem has been to get a grade with the proper conductivity, flexibility and resilience. A modified temper of 17,000 to 22,000 psi tensile has been developed and is known as ED. This temper shows 60% of the tensile strength of full hard EC-H19. In joints, welded terminals give the best service. Solder and compression fittings are also used successfully.

The new applications and developments of magnesium alloys were discussed by J. D. Hanawalt and G. K. Glaza, of the Dow Chemical Co. The majority of the uses of magnesium so far have been die castings to replace intricate iron castings or machined aluminum castings. An oil pump and a generator end plate were early applications. New uses may include clutch and transmission parts, rocker box supports, oil seals, instrument panels and windshield motor end plates.

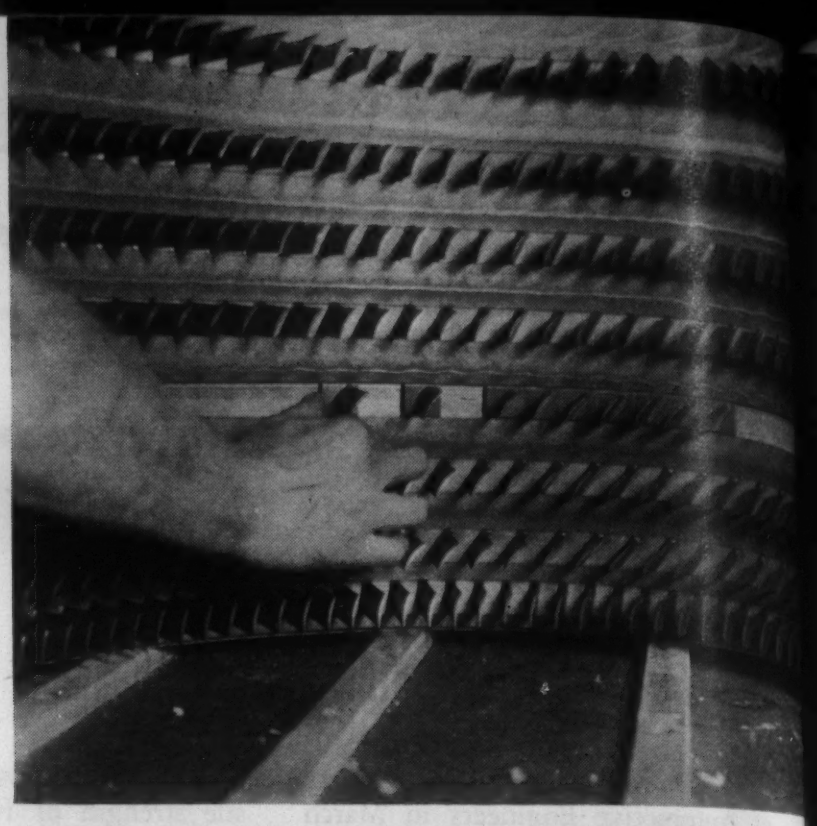
Magnesium truck wheels, hubs, brake shoes and spiders are also being studied. At present the cost is too high for passenger automobiles. In commercial vehicles, weight is more important, and magnesium may be in commercial use shortly.

Television, normally an item for the living room, has gone to work in The Timken Roller Bearing Co.'s steel mill. A dispatcher, who controls the rate of speed for the conveying system which transports seamless tubing into low temperature furnaces, was forced to virtually be in two places at once. Due to the arrangement of the conveyor system and the furnace, it is necessary for him to be located 80 ft from the charging end of the furnace. From that distance, it was impossible for him to detect a jamming of the flow of tubing.

To solve the problem, Timken engineers installed a television camera aimed at the furnace door. A coaxial cable connects the camera with a receiver right at the elbow of the dispatcher 80 ft away. In this way he can keep a constant check on the tubing as it enters the furnace.



A complete fabricated jet engine blade is shown at left. On the right is the forged blade currently used. The fabricated process has been approved for production by the Air Force, for use in the stator, or stationary, portion of the compressor.



Fabricated blades are simply inserted into place in slots in the compressor casing. The other blades shown here are forged. They have been inserted in a blade ring, and the rings, in turn, have been inserted into the casing slots.

Gas Turbine Blades Now Fabricated by Welding

A new manufacturing process designed to crack a bottleneck in the nation's aircraft turbojet engine production program has been announced by the General Electric Co. Developed by the company's Thomson Laboratory at Lynn, Mass., the process involves fabrication of the stationary, or stator, blades of jet compressors in place of the relatively slow and expensive forging technique currently used.

In addition to greatly speeding up blade manufacture, the process promises savings in critical materials and in jet engine costs to the armed forces. The critical material savings are estimated at 39% because of virtually chipless production, which reduces waste. Cost reductions of 55% in stator blade manufacture are claimed to be possible. Blade fabrication will also relieve pressure on forging facilities. In addition, considerably less production equipment is needed for fabricated blades as compared to forged blades, and the equipment is less costly than that used in forging.

The Air Force has approved substitution of fabricated blades for forged blades in the General Electric J-47-GE-23 turbojet, which is going into large-scale production for the jet-powered medium bomber, the Boeing B-47 Stratojet. Additional production facilities, earmarked for blade fabrication, are planned for the company's Lockland, Ohio, turbojet center. Details of the fabrication process, which cannot be revealed publicly for security reasons, would be made available through the USAF to other turbojet manufacturers in the nation.

The compressor, the heart of a jet engine, forces air into the combustion chambers. It consists of a rotor and a stator. The rotor is cylindrical, with blades affixed to its outer surface. Surrounding the rotor is the stator which has stationary blades. The stainless steel blades on both the rotor and stator are precision manufactured. As the rotor turns, air is forced through the rotor and stator blades and compresses as it travels to the rear toward the combustion chambers.

The fabrication process has been approved for the stationary blades, while the rotary blades will continue for the present to be forged because of the high centrifugal stresses involved.

In the precision forging process, the blade and its base are hammered from a single piece of stainless steel. The air foil is formed during the hammering process. The base is dovetailed so as to fit into a blade ring, and the rings holding the stationary blades are pushed into slots in the compressor casing.

Anticipating that the forging process would constitute a bottleneck to mass production, the Aircraft Gas Turbine Div. three years ago handed the problem to metallurgists of the Thomson Laboratory at Lynn, Mass. Their instructions were to determine whether blades could be manufactured without forging, but still interchangeable with forged blades. Investigation turned to a principle used in steam turbine manufacture whereby the blades are rolled in long strips, contoured to the proper air foil, and then cut to the desired length.

The engineers found the process adaptable to turbojet manufacture. The base for the blade, which is an integral part of the forged blade, was a big problem. It took two years to work out a way of making a separate base with an opening into which the blade could be inserted and welded. The base is shaped to fill the same area as the present blade ring, thereby eliminating the ring and an expensive manufacturing and assembly process.

The design of the base is such that it provides resistance against vibration that may occur due to occasionally uneven air flows through the compressor. The new blade is strongly fastened to the casing, which will minimize the damage caused by a foreign object entering the compressor.

Limited production of blades for engine testing was begun in late 1950. Performance tests were run on two engines equipped with fabricated stator blades before any substitution was authorized. After 500-hr endurance tests, thorough examination showed no undesirable conditions or signs of future failure, according to engineers. Performance tests showed no change in efficiency compared to engines with forged blades, and one test showed a slight increase in efficiency, although the engineers said this probably was not significant.

Yale & Towne Executive Discusses Materials Problems in Hardware

How the use of alternate metals in the manufacture of locks and builders' hardware brought about by CMP limitations of critical metals has been successfully accomplished was shown by The Yale & Towne Manufacturing Co. at its product display at the National Home Builders Show in Chicago.

Leo J. Pantas, general manager of the Stamford Div. of Yale & Towne, pointing to his company's use of alternate metals for certain standard products, said that "builders and consumers will have to recognize that the builders' locks and hardware industry has an inadequate allocation of brass to meet the requirements of the 1952 building market."

"To maintain sufficient volume, however, to meet the needs of our customers, we are making several items formerly made of brass out of alternate metals," he continued.

Yale products on display at the builders' exposition that are now being produced in alternate metals included tabular locks for application on inside doors, which are made of brass finished steel instead of solid brass; some miscellaneous hardware products for doors and windows, formerly made of brass and now made in brass finished cast iron and steel; and a screen door closer, which is fabricated out of steel instead of brass.

In addition to such modifications in the metal content of certain products, it was also pointed out that Yale has suspended most chromium finished products because of unavailability of chromium.

On the other hand, the display also contained a wide variety of products that will continue to be manufactured out of brass. Among these are key-in-the-knob type residential tubular locks for exterior door application, many miscellaneous hardware products for doors and windows, and a full line of cabinet locks and padlocks.

"When first introduced to the market," Mr. Pantas declared, "some of the products made out of alternate metals encountered some sales resistance. But there now seems to be a growing acceptance of them," he stated.

As an appraisal of the ability of the builders' hardware industry to supply the 1952 building market, Mr. Pantas said: "We shall certainly have difficulty in serving the market if there is an insistence upon brass products for all applications. If, however, buying habits change and builders and consumers accept hardware made out of steel and other metals for certain applications, there will be enough builders' locks and hardware available to serve most normal needs."

Edwin F. Cone

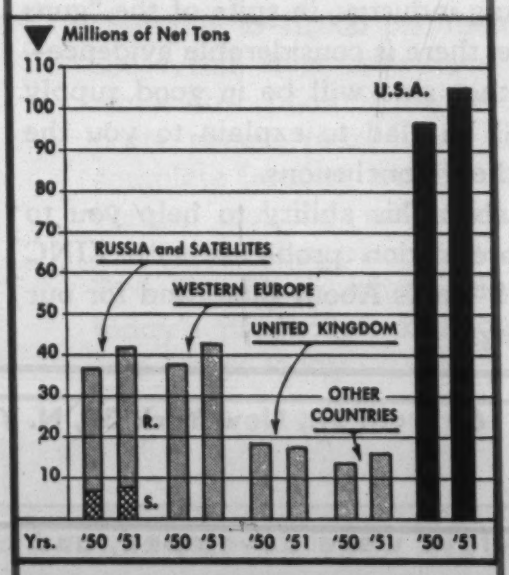
The publishers of MATERIALS & METHODS report with sadness and regret the death, on March 18th, of Edwin F. Cone, one of this country's distinguished journalists, and editor of this paper from 1935 to 1943 when it was known as *Metals and Alloys*. Mr. Cone retired from the staff in 1947. He has been ill for several months past.

Mr. Cone's career was long and studded with outstanding achievements and innumerable friendships. He had already reached a position of eminence as a chemist and metallurgist in the steel foundry industry before joining *The Iron Age* prior to World War I. He served *The Iron Age* as associate editor for 20 years, and in 1935 became editor of *Metals and Alloys*, which was then a metallurgical engineering magazine. Under his editorial direction the magazine in the next eight years developed a distinctly practical engineering approach, quadrupled its circulation, and assumed its place as one of the world's foremost technical journals.

"Doc" Cone had more real friends than there are words on a printed page, for he was one of the kindest and most cheerful men we have ever known. He was a member of the ASTM, AIME, the ASM, the Electrochemical Society, the AFS, and the National Conference of Business Paper Editors, and a past officer and active committee worker of most of them. During World War II he served on the Washington staff of the War Metallurgy Committee.

His friends in all these fields will share with his former coworkers at Reinhold our deep sense of sadness at the passing of an old friend, coupled with happy memories of our association with him.

Steel Production Rises in Most Countries



Courtesy American Iron & Steel Institute

Conservation of Critical Materials Cited by Secretary of Army Pace

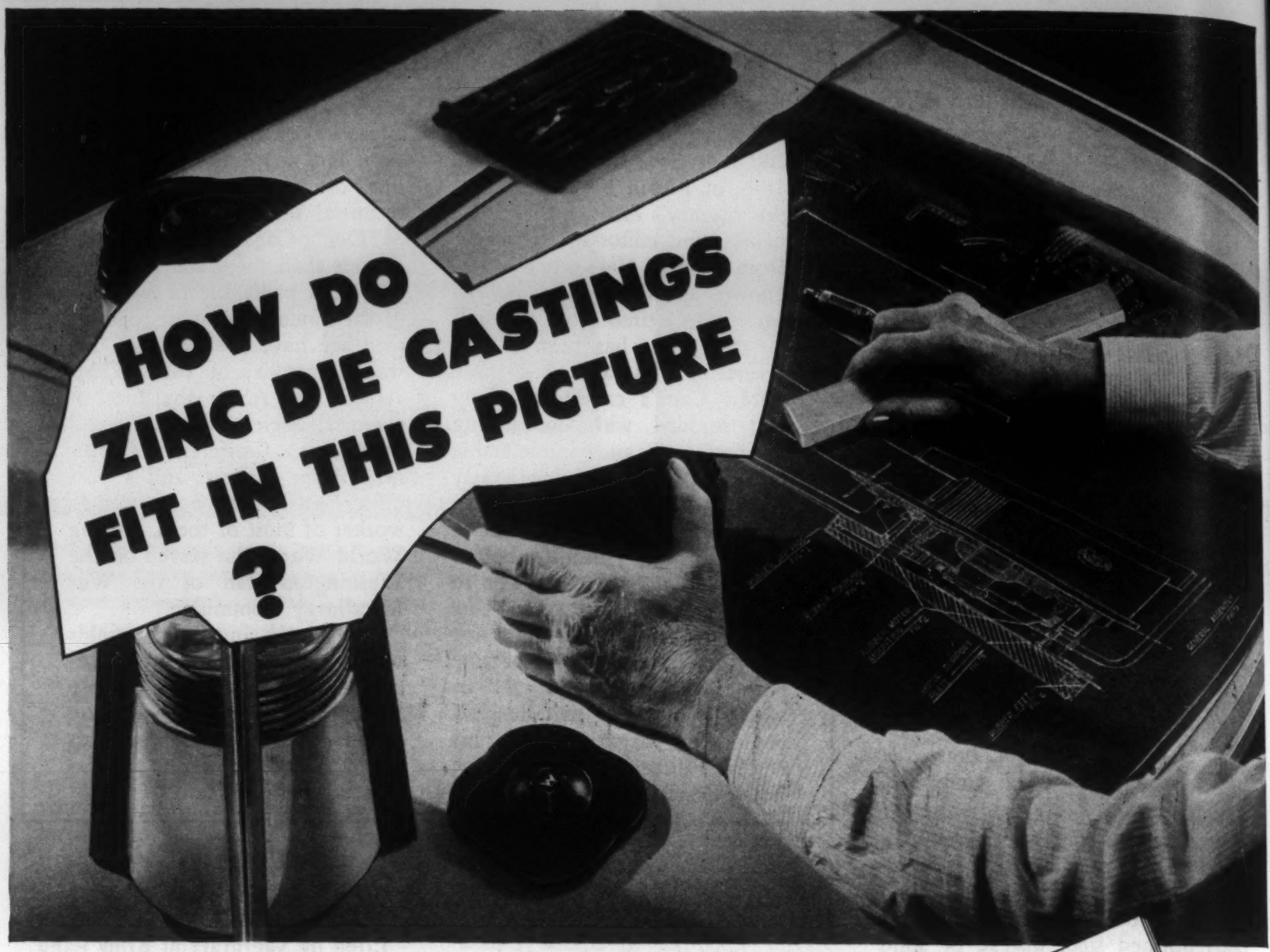
Secretary of the Army Frank Pace, Jr. has announced substantial savings in Army use of critical and strategic materials by a program of conservation and substitution of more readily available materials.

The Army initiated the conservation program in Sept. 1950, to effect the most efficient and economical use of resources. This is being accomplished primarily by substitution of less essential materials in ample supply, and in many instances by simplification of design, providing this does not involve sacrifice of essential military or safety characteristics.

The Army Technical Services implement the program by constant review of materials used in items of procurement, and continuing tests to determine where further economies can be made.

Secretary Pace, in announcing the savings, pointed out that by using less strategic materials in plentiful supply, the Army can eliminate production delays and speed delivery of essential equipment. He also said that by using reduced amounts of critical materials now, the available supply is extended for future use, and Army demands on the national stockpile can be held to a minimum.

(Continued on page 13)

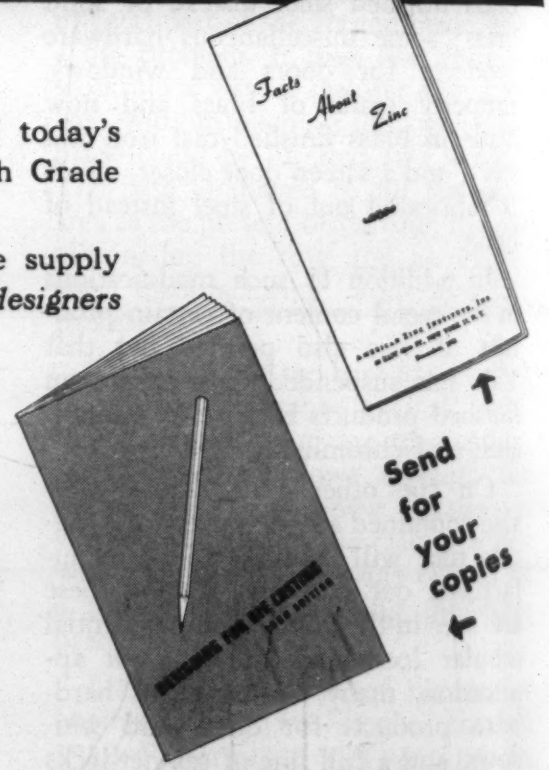


Selection of materials is probably the major problem of most of today's product designers. As one of the leading suppliers of Special High Grade zinc to the die casting industry, we wish to make this statement:

> A careful examination of all of the factors which influence the supply of Special High Grade zinc lead to the conclusion that *product designers should continue to take advantage of ZINC Die Castings.*

Admittedly a major change in the present world military picture would alter the outlook with respect to the supply of *all* metals. However, now that the military needs for zinc have been reasonably well established, there is every reason to believe that ample supplies are available to the die casting industry, in spite of the "guns and butter" economy. Furthermore, there is considerable evidence—based on a world-wide analysis—that zinc will be in good supply for a long time to come. We will be glad to explain to you the various factors which lead us to these conclusions.

Ask your die casting supplier about his ability to help you to meet your current design and production problems with ZINC Die Castings. Ask us for a copy of "Facts About Zinc" and for our booklet "Designing for Die Casting."



Send for your copies

The New Jersey Zinc Company, 160 Front St., New York 38, N. Y.

ZINC
FOR DIE CASTING ALLOYS

The Research was done, the Alloys were developed, and most Die Castings are based on
HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

News Digest

continued from page 11

In a single 3-month period—the second quarter of fiscal year 1952—the Army conservation program saved the following amount of critical and strategic materials:

Zinc	200,000 lb
Copper	4,394,000 lb
Aluminum	122,000 lb
Nickel	225,000 lb
Wool	95,000 lb
Cotton Duck	240,000 lb
Natural Rubber	853,000 lb

Secretary Pace emphasized that the Army is constantly seeking new methods to conserve vital materials. The use of other alloying materials to replace nickel in certain steel alloys shows promise in many applications. The use of plastics and wood to replace essential steel and aluminum is undergoing exhaustive tests.

The Army is also exploring uses for new materials such as titanium and germanium.

NPA Drops Restrictions on Lead as Supply Increases

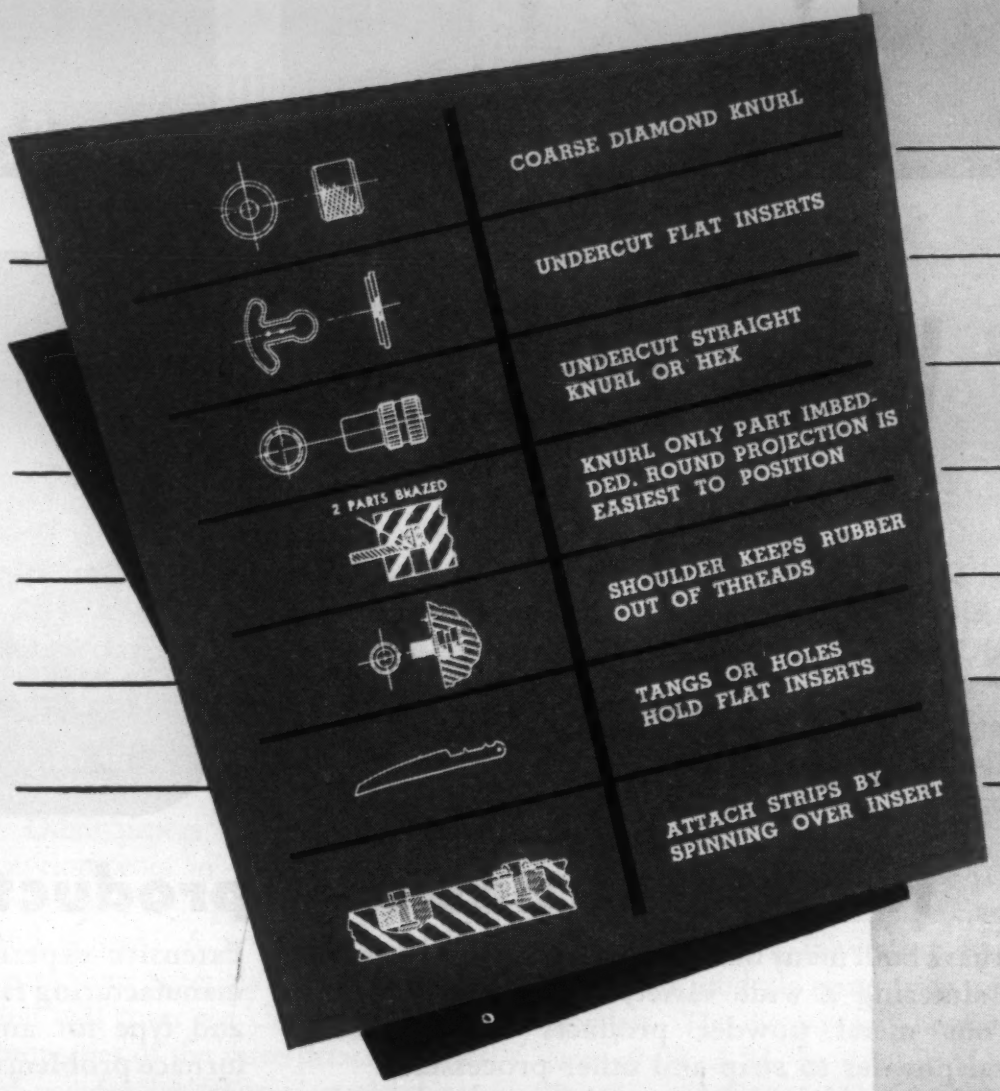
Removal of all Government restrictions on the use of lead has resulted from substantially increased supplies of the metal now available to American consumers. Lead is the first common metal with widespread industrial applications to be thus freed by the Government. With the removal of NPA restrictions, consumers may use all the lead they need for its regular applications and may even employ it to relieve the strain on materials which are still scarce.

In 1951 supplies in the United States were greatly reduced by the diversion of lead to foreign buyers because they were willing and able to pay prices above the ceiling prices to which domestic consumers were required to adhere. Imports in 1951 were only 267,000 tons, less than half the 550,000 tons imported in 1950.

However, having purchased heavily in 1951 and being faced with currency difficulties now, foreign buyers no longer are paying high prices for lead. The foreign market has receded to a point where large quantities of foreign lead are now available for export to the United States. In addi-

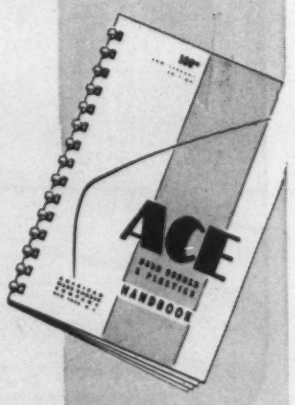
(Continued on page 188)

MATERIALS ENGINEERING FACTS



hints for molding metal inserts in ACE HARD RUBBER . . .

It takes no less than 70 pages in the new Ace Handbook to cover the amazing versatility of Ace Hard Rubber! For instance, you'll find a choice of many different compounds . . . tensile strengths to 10,000 psi, dielectric strength over 600 v/mil, heat resistance as high as 300°F., water absorption as low as 0.04% . . . in molded parts, sheets, rods, tubes and linings . . . with complete (among world's largest) facilities for design, molding, extruding, finishing . . . for thousands of applications. Always check your Ace Handbook when selecting materials for today's production and tomorrow's plans. It's free—write today.



100th ANNIVERSARY

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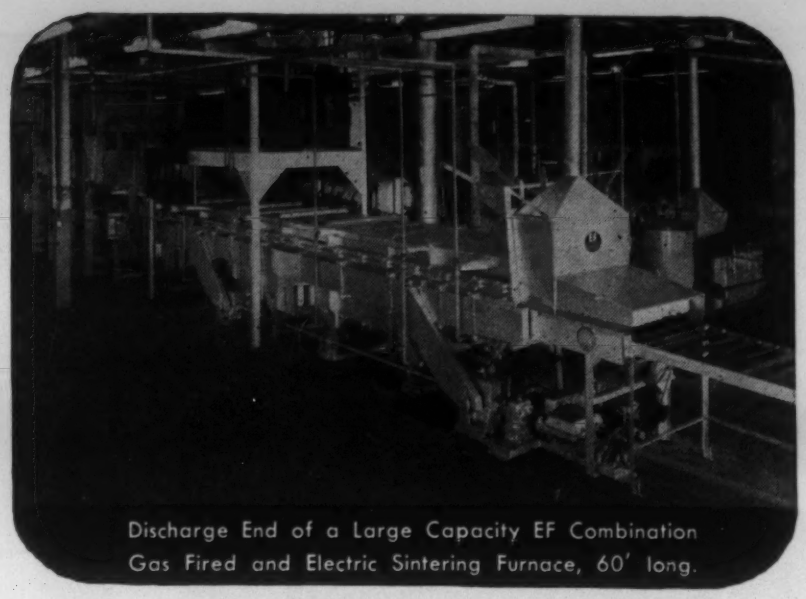
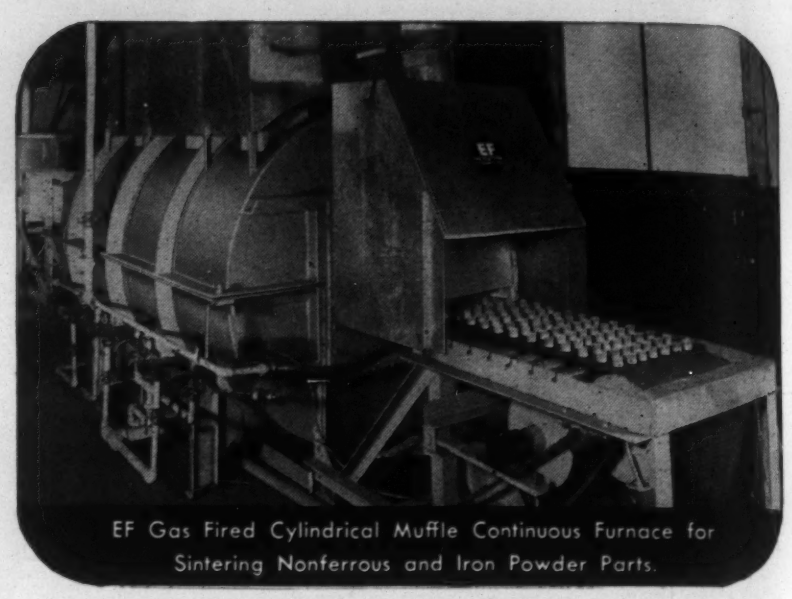


Discharge End of a Large Capacity EF Combination Gas Fired and Electric Sintering Furnace, 60' long.

Small EF Hand Operated Pusher Type Electric Furnace Suitable for Experimental and Small Production Runs.

Know How and Proved Performance

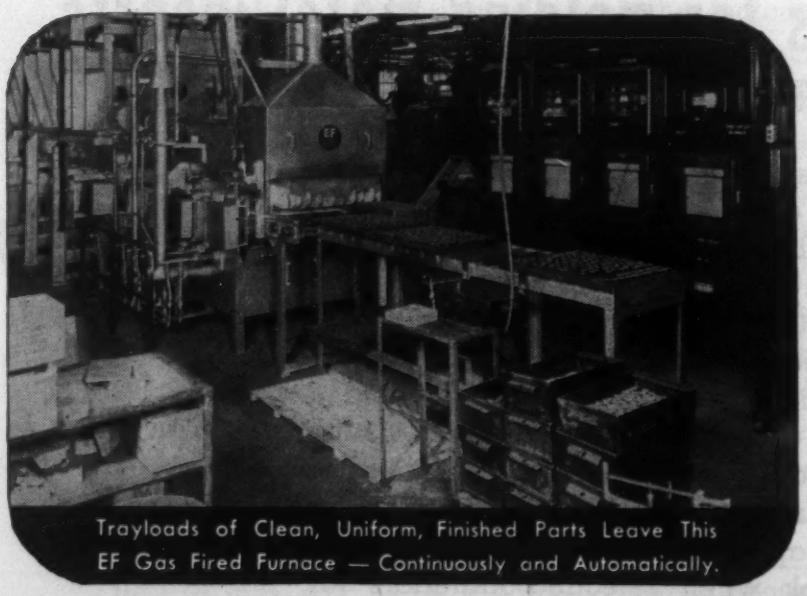


EF Gas Fired Cylindrical Muffle Continuous Furnace for Sintering Nonferrous and Iron Powder Parts.

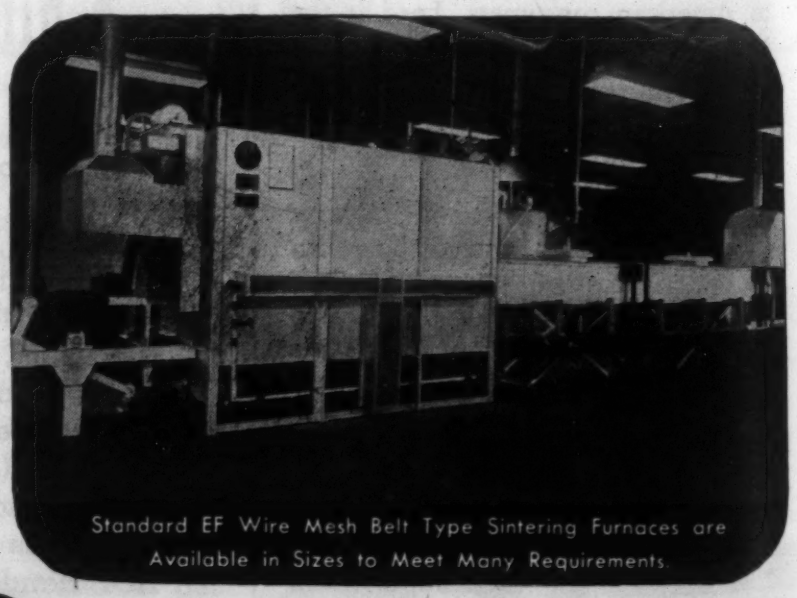
for metal powder products producers

We have built many outstanding production furnaces for sintering a wide variety of ferrous and non-ferrous metal powder products — for bonding metal powder to strip and other processes.

Extensive experience and complete engineering and manufacturing facilities enable us to build the best size and type for any requirement. Put *your* production furnace problems up to experienced engineers—*it pays.*



Trayloads of Clean, Uniform, Finished Parts Leave This EF Gas Fired Furnace — Continuously and Automatically.



Standard EF Wire Mesh Belt Type Sintering Furnaces are Available in Sizes to Meet Many Requirements.

Gas-Fired, Oil-Fired EF and Electric Furnaces

for any Process, Product or Production

THE ELECTRIC FURNACE CO.

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Preview of

1952 Metal Powder Show

and

Eighth Annual Meeting

"Powder Metallurgy in a Defense Economy" will be the theme of the 1952 Metal Powder Show, to be held on Apr. 29 and 30 in Chicago at the Drake Hotel. The show and meeting is again being sponsored by the Metal Powder Association, and should be of interest to everyone in the field. Besides an outstanding technical program, there will be exhibits by leading metal powder producers, metal powder parts fabricators, and equipment manufacturers.

The theme of the show is reflected in four of the papers to be presented at the two-day technical session. Subjects to be discussed specifically on ordnance include iron powder rotating bands, brass and iron powder fuse mechanism components, small arms ammunition from iron powder, jet engine blades and vanes, carbide core tips for armor piercing projectiles, and iron powder electronic core materials that are in use by the Signal Corps.

Other papers will cover the latest developments in powder metallurgy techniques and applications both here and abroad. A symposium of electronic core materials also will be held and will cover the characteristics and properties of the three principal types of powder, including electrolytic, carbonyl and hydrogen reduced powders. Another paper of wide interest will be one covering recent practical applications of hot pressing.

All technical sessions will be held in the meeting room that is adjacent to the exhibits located in the Drake Hotel.

Besides the technical program, there will be a reception and buffet supper on Tuesday and a luncheon on Wednesday.

The exhibits will feature the latest developments of leading producers of metal powders, fabricating equipment, and products made from metal powders. The displays will be shown from 9:00 A.M. to 7:00 P.M. on Tuesday and 9:00 A.M. to 5:00 P.M. on Wednesday.

Below is given a detailed program as well as a short summary of most of the technical papers.

Program

Tuesday, April 29

10:30 A.M.

Recent Practical Applications of Hot Pressing — Jerome F. Kuzmick, Welded Carbide Tool Co.

This paper will cover hot pressing as applied to tungsten carbide, beryllium, heavy metals, diamond bits, etc.; possible uses of hot pressing for steel dies, high temperature alloys and cermets. Also included will be discussion of types of presses and molds for hot pressing of metal powders.

11:15 A.M.

Powder Metallurgy in the Manufacturer of Clocks and Mechanisms — Fred Lux, Lux Clock Manufacturing Co.

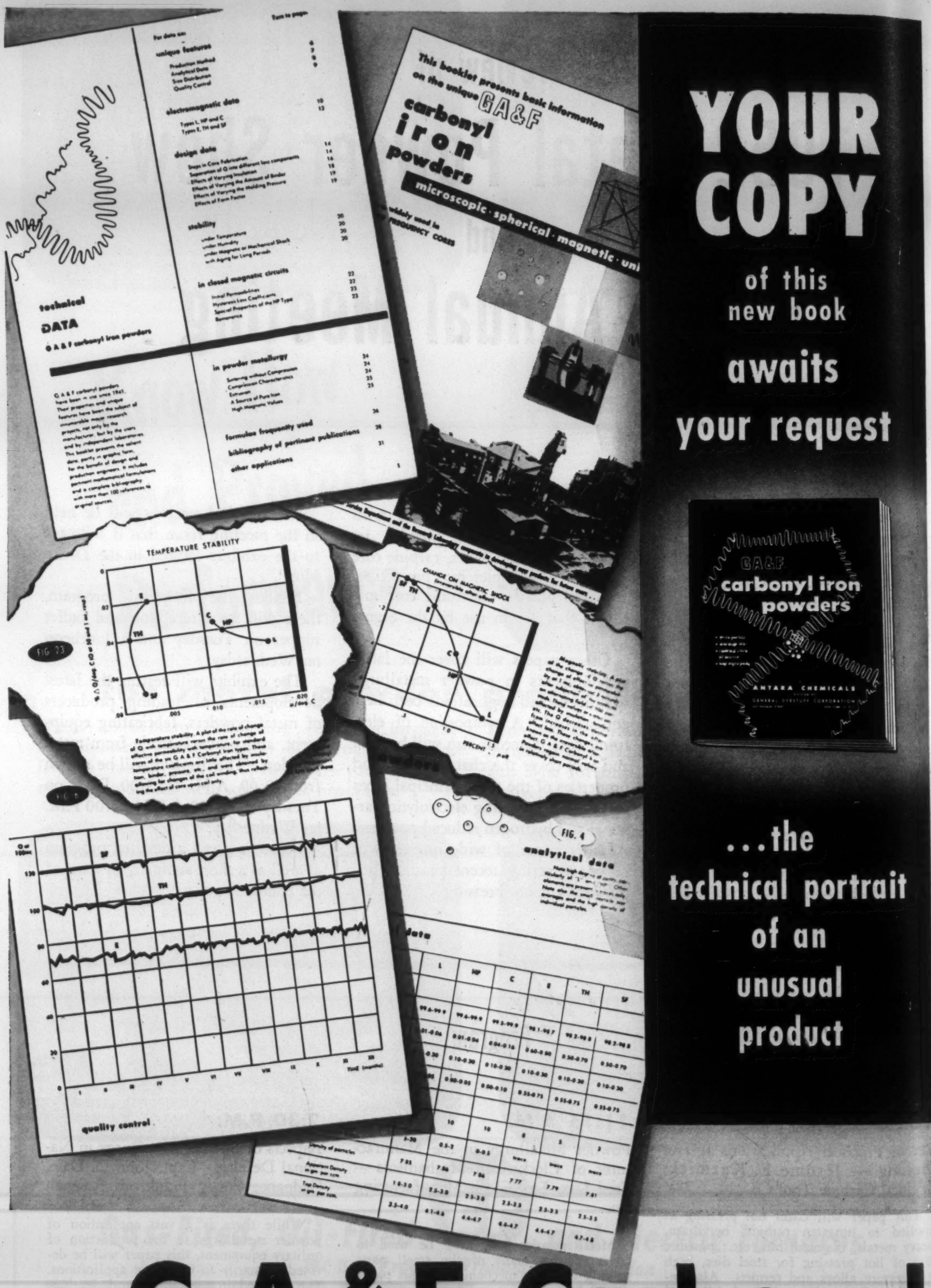
Metal powder parts can be used to advantage for many of the small parts making up clock mechanisms. This paper describes one company's experiences in adopting powder metallurgy for large volume production of such parts.

2:30 P.M.

Aspects of Powder Metallurgy in National Defense—Capt. John D. Dale, Ordnance Corps, Frankford Arsenal.

While there is a vast application of powder metallurgy in the production of military equipment, this paper will be devoted primarily to Ordnance applications. The sintered iron rotating band development program will be reviewed with an

(Continued on page 19)



G A & F® Carbonyl

up-to-date summary of the status of the program. Development work and production activities in fuze components will be summarized, and a review of small arms ammunition applications will be made. In most cases a comparison will be made with former methods of manufacture to illustrate the advantages which have been or which will be obtained through the powder metallurgy technique.

3:15 P.M.

Powder Metallurgy in High Temperature Applications — Julius J. Harwood, Metallurgy Branch, Office of Naval Research.

Expanded production of jet engines and the development of new and improved gas turbines, guided missiles and rockets are currently posing two serious materials problems: (1) the necessity of conservation of critical alloying elements; and (2) the need for refractory materials capable of withstanding conditions of high temperatures and severe operating stresses. The role of powder metallurgy in assisting in the solution of these problems will be discussed. Typical present and potential applications of powder metallurgy techniques and processes will be presented.

4:00 P.M.

The Use of Carbide Cores in Ordnance Applications—Malcolm F. Judkins, Firth Sterling Steel and Carbide Co.

This paper will review the use of cemented carbide materials in military items.

5:30 P.M.

Reception — Cocktails and Buffet — Grand Ballroom.

Wednesday, April 30

10:00 A.M.

Symposium on Electronic Core Materials. Chairman: W. E. Cairnes, Radio Cores, Inc.

Electrolytic Iron Powder — W. M. Shafer, Plastic Metals Div., National Radiator Co.

Electrolytic iron powder is a high purity material produced with a range of particle sizes and shapes suitable for a variety of magnetic core applications. This paper will cover the properties and characteristics of these powders.

Carbonyl Iron Powder — George O. Altmann, General Aniline & Film Corp.

The structural characteristics of carbonyl iron powders will be described and their relation to the electromagnetic properties of high-frequency cores containing these powders discussed.

Hydrogen Reduced Iron Powder — R. H. Rodrian, C. K. Williams & Co.

10:45 A.M.

Magnetic Powder Cores for Military Communications Equipment — Eberhard Both, Signal Corps Engineering Labs.

The need for the development of improved magnetic powder cores for military communication equipment will be demonstrated by comparing the characteristics of present materials with those required for the stable and dependable operation of the equipment under the extreme environmental conditions encountered in modern warfare.

11:30 A.M.

Progress in Powder Metallurgy in Europe—W. D. Jones, Powder Metallurgy Ltd., London.

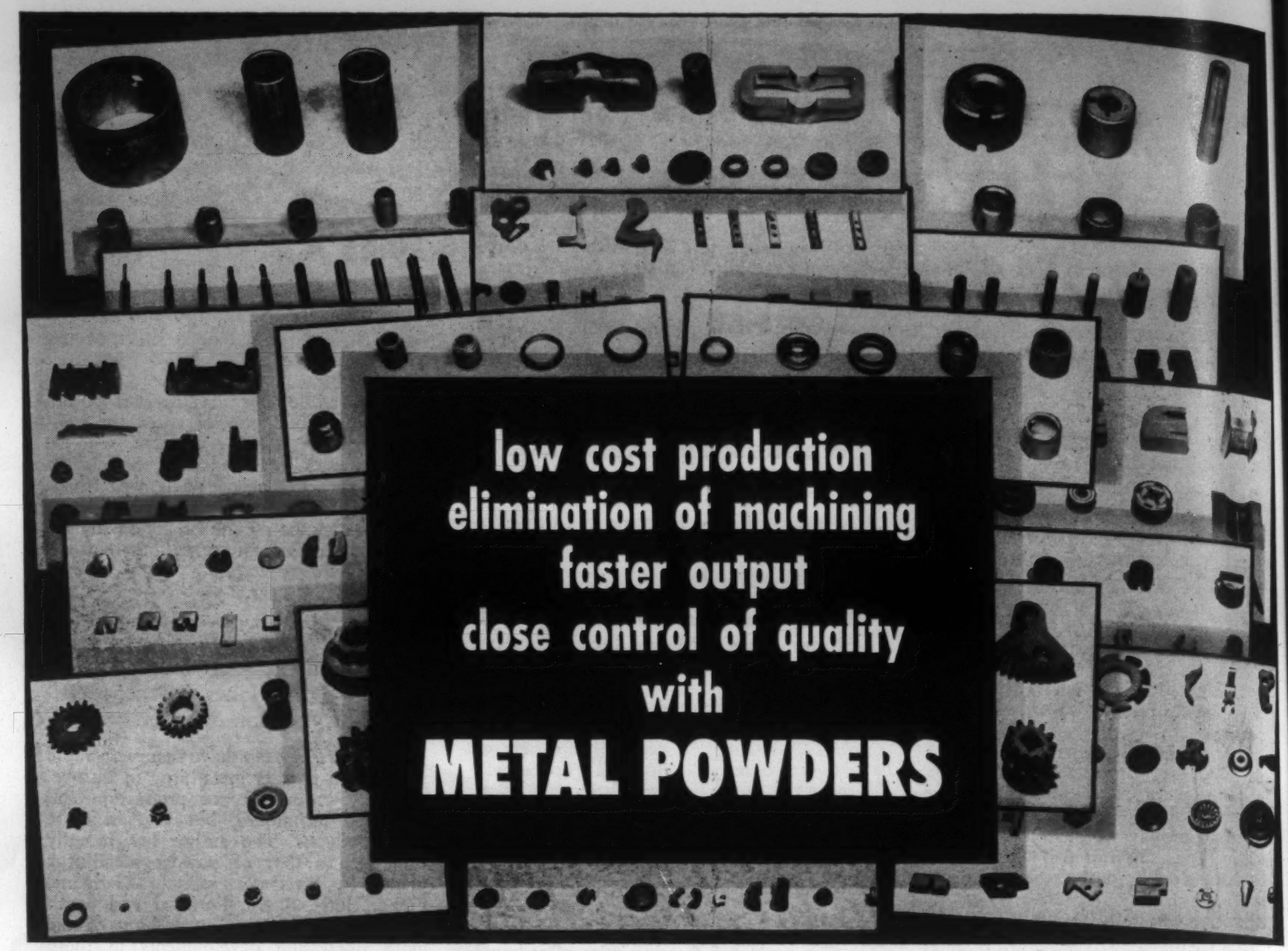
The last few years have seen very rapid progress in powder metallurgy in Europe, not only in quantity of production and improved techniques, but also in quite new products. The author has recently completed a tour of powder metallurgy plants in Sweden, Holland, Germany, France, Italy, Spain, Portugal and South Africa, and will give an account of the more interesting developments in those countries and in Britain.

12:45 P.M.

Luncheon—Gold Coast Room (Guest Speaker to be announced).

List of Exhibitors

Exhibitor	Booth No.
Amplex Manufacturing Co.	24, 25
Antara Products Div., General Dyestuff Corp.	7
Arthur Colton Co.	28
Ekstrand and Tholand, Inc.	10
Electric Furnace Co.	4
Federal-Mogul Corp.	19
The Glidden Co.	26
Charles Hardy, Inc.	29
Harper Electric Furnace Co.	9
Johnson Bronze Co.	22
Kux Machine Co.	32
Lindberg Engineering Co.	27
Machine Design Magazine	3
Magnetic Powders, Inc.	17
Materials & Methods Magazine	21
Metal Hydrides, Inc.	31
Metals Disintegrating Co.	6
New Jersey Zinc Co.	2
Plastic Metals Div., National Radiator Co.	23
Powdered Metal Products Corp.	18
Precision Metal Molding Magazine	14
Radio Cores, Inc.	8
Reinhold Publishing Corp.	21
Stackpole Carbon Co.	16
F. J. Stokes Machine Co.	11, 12, 13
Welded Carbide Tool Co.	15
The Wel-Met Co.	30
Westinghouse Electric Corp.	20
Western Gold and Platinum Works	5



Plastic Metals, with 18 years experience in the development of metal powders, is one of the leading suppliers of this important material to metal powder part fabricators. A continuous expansion program has provided facilities having capacities adequate to meet the constantly increasing demands for the metal powders listed below:

PLAST-IRON—a high quality electrolytic iron powder of extreme purity—ideally suited for electrical, magnetic and high physical property applications.

PLAST-SPONGE—a reduced oxide type of iron powder specially characterized by excellent compressibility and high sintered strength.

PLAST-STEEL—prepared to customers' specifications by special processing of iron powder with carbon, manganese and other elements to produce specified steel analyses.

PLAST-CORIRON—grade of iron powder developed specially for the production of television transformer cores. Noted for exceptional permeability and Q values in frequency range of 10 to 100 K.C.

PLAST-NICKEL—a high grade nickel powder, with purity ranging from 98% to 99%. Either spherical or irregularly shaped particles can be supplied.

PLAST-MANGANESE—produced from electrolytic manganese having a minimum purity of 99.9%.

PLAST-SILICON—contains approximately 98% silicon and is available in apparent densities from 0.75 to 1.5 grams per cc.

If you are manufacturing parts for military materiel—or for any civilian product where metal shortages are causing production problems—we shall be glad to put you in touch with qualified metal powder part fabricators for a discussion of the practical possibilities of metal powders for your specific needs.

VISIT OUR EXHIBIT AT

The Metal Powder Association Meeting
Drake Hotel
Chicago, April 29-30, 1952

PLASTIC METALS

DIVISION OF THE NATIONAL RADIATOR COMPANY
JOHNSTOWN, PENNSYLVANIA

Materials & Methods
APRIL 1952

Materials Engineering Department at Westinghouse Develops, Improves and Applies Materials

by T. C. DU MOND, Editor, Materials & Methods

The basic objectives and philosophies which guide the operation of this well-organized and efficient materials engineering group can serve as a pattern for companies, large or small, contemplating such a department.

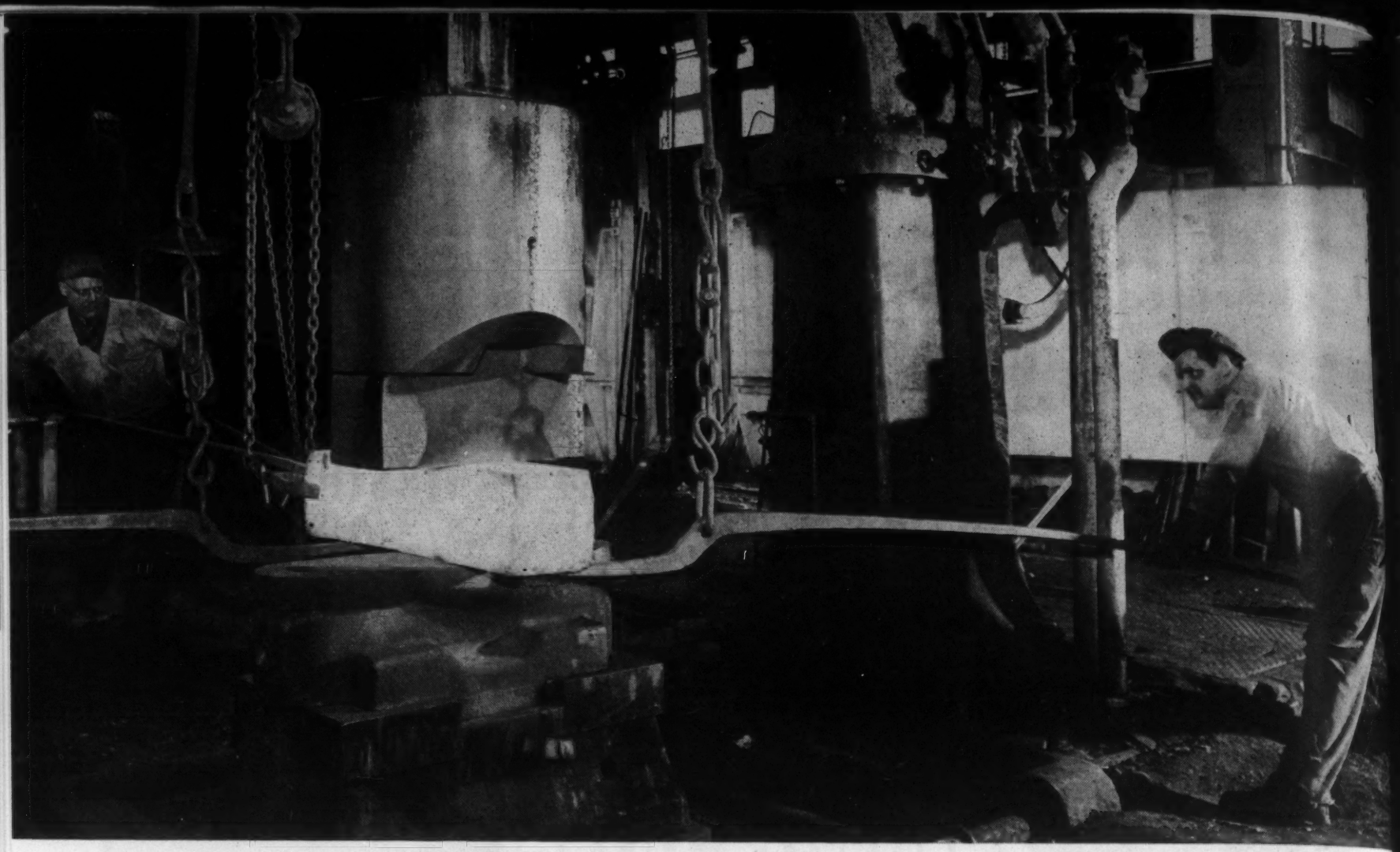
● WESTINGHOUSE ELECTRIC CORP. thinks of itself as, primarily, an engineering organization. Therefore, it is not surprising that this giant corporation pays a great deal of attention to the engineering aspects of the thousands of materials required to produce the countless varieties of products which it makes. Because of this, Westinghouse has one of the largest and best organized materials engineering departments to be found in industry.

Actually, Westinghouse maintains materials engineering departments at all of its major plants, but at East Pittsburgh, Pa., there is a large department supported by all divisions of the company which acts, among other things, as a consulting organization on materials problems that might develop anywhere throughout the company.

The analogy between the Westinghouse headquarters Materials Engineering Dept. and a consulting organization is further emphasized when one examines the method of financing the department. Approximately two-thirds of the cost of operating the department is covered by direct allocation of funds from each participating division of the company. The additional one-third comes from general funds of the company to cover the expense of necessary development which cannot be charged to any one part of the company's operation. However, the department offsets the costs of some of its activities by running them as miniature pilot plant production units and selling their output to operating divisions of the corporation.

The overall materials engineering operation of Westinghouse looks

Most of the latest research equipment is to be found in the laboratories of the Materials Engineering Dept. Here a spectrograph is used to analyze metal samples.



After the department developed Discaloy, it established processing and fabricating techniques for use of outside fabricators.

something like this:

The headquarters Materials Engineering Dept., employing more than 500 people, of whom 150 are technically trained, devotes most of its activities to company wide materials problems, carries on specialized development and investigation for the divisions of the company located at East Pittsburgh, and assists, when called upon to do so, in solving materials problems which arise at other plants of the company. In 20 other plants of the company there are materials engineers at work. The size of the departments range from a few which have but one man in them to others which employ a dozen or more men. As might be expected, the men stationed at the various plants are experts in the materials problems that are most prevalent in their own plants.

Specialties of some of the plants Materials Engineering Depts. are as follows: Philadelphia devotes its major attention to high temperature materials and special alloys for gas and steam turbines. Bloomfield, N. J., materials men are specialists in tungsten, molybdenum, glass and other materials used in vacuum tubes as well as other special materials for lamps. Porcelain enamels and other special finishes for appliances demand attention of the Mansfield, Ohio materials engineering department. Sharon, Pa., where transformers are made, needs specialists in insulating liquids and transformer core materials. Experts in laminated phenolic plastics materials make their headquarters at Trafford, Pa.

Complete cooperation exists between the various Materials Engineering Depts., and information is exchanged freely. Not only do the plants away from Pittsburgh refer problems they cannot answer to the headquarters group, but also the headquarters group relies upon the plant specialists for help when it gets stuck.

Functions of the Department

For the sake of simplicity, the remainder of this report will be restricted to the activities of the headquarters materials engineering group. It has been chosen, first because it is the largest, and second, because actvities of the group cover all types of materials engineering activity.

According to the philosophy of Mr. J. B. Seastone, engineering manager, Materials Engineering Dept., the purpose of the department is sixfold:

1. The foremost activity of the department is the development and application of engineering materials. Materials, of course, cover all of the ferrous and nonferrous metals, plastics and other nonmetallic materials as well as the parts and forms in which materials are used, and insulation and all types of protective and decorative finishes.

2. The Materials Engineering Dept. spends a good portion of its time and energy in converting materials research developments into practical application. In other words, this group strives to find commercial applications for discoveries made in the company's research laboratory, and serves as a link between the theoretical and the practical.

3. As new materials are developed and come to the attention of the department, they are evaluated to determine their properties and to see how they might fit into the products the company is now making or might be contemplating.

4. Assist in solving manufacturing problems. This function includes setting up processing techniques and proving them as well as helping manufacturing departments overcome difficulties which might stem from the properties or characteristics of the materials being used.

5. The department has the responsibility for certain chemical or physical tests on incoming materials to see that they meet specifications. For this purpose it has a modern laboratory which is equipped with practically every known type of testing equipment for metals and nonmetallic materials.

6. The department provides technical assistance to the purchasing department. This function includes

helping to establish purchasing specifications, finding alternate materials and alternate sources of material, and interviewing representatives of materials suppliers attempting to sell to the company.

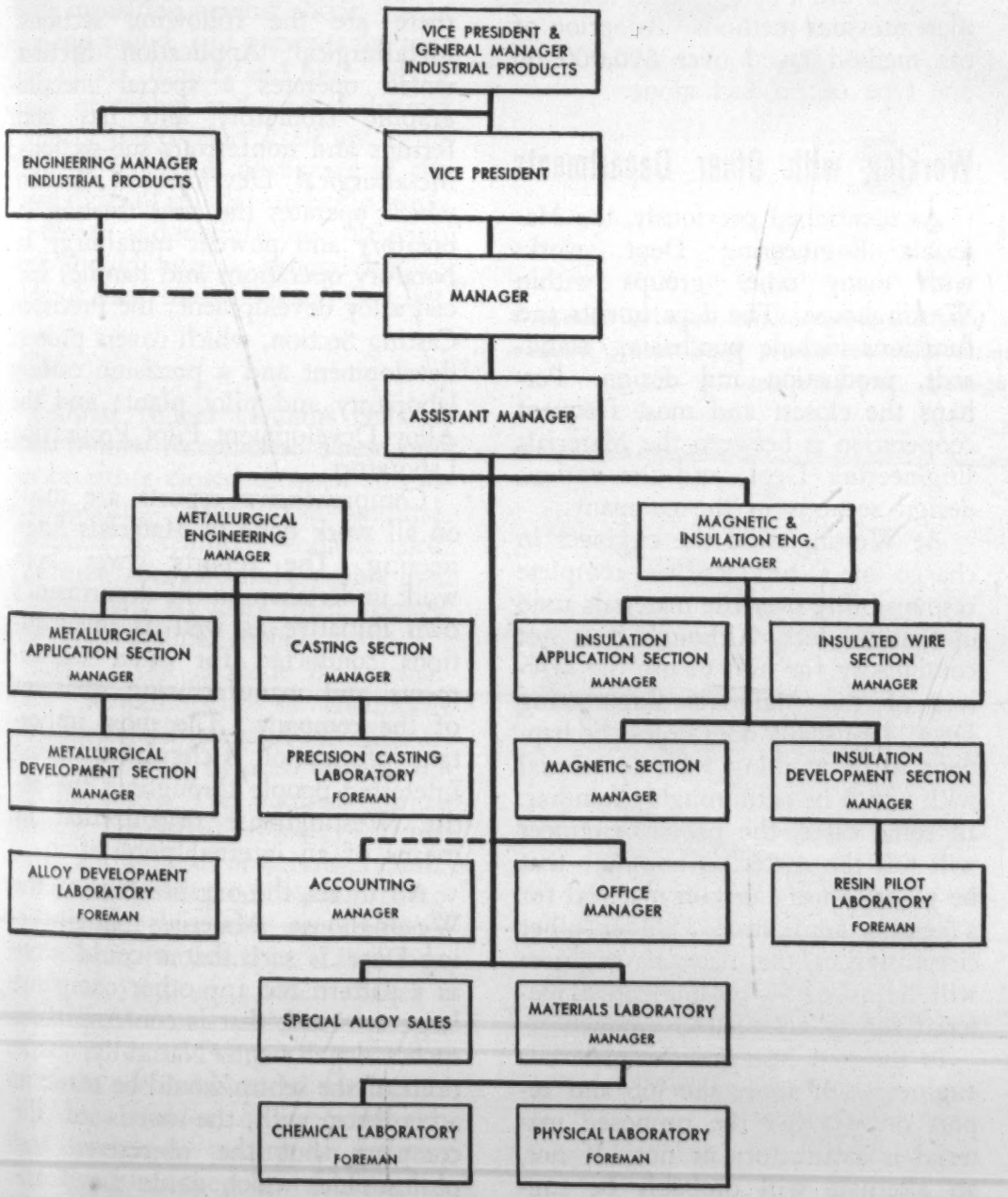
There are several guiding principles which govern activities of the department. First and foremost, there is a well founded plan of doing things by thorough engineering and comprehensive laboratory work. Also, the department seeks to serve as a proving grounds for both materials and processes.

Other functions of the department which fall within these activities could be listed further to include:

Aiding Suppliers — Should there be some discrepancy between specified and delivered goods, the Materials Engineering Dept. often works with suppliers to overcome difficulties in meeting specifications.

Pilot Plant Operations—The Materials Engineering Dept. often sets up pilot plant operations to produce materials or to establish methods of producing components. In the past, this function has taken new alloys and resins from the research stage through the pilot plant operation. Furthermore, it has set up plating, heat treating, precision casting and powder metallurgy departments. Pilot plant operations of the department are based on a strong, and often proved, belief that only when pilot scale quantities of materials or parts are produced do variables show up. When developments of the department have met and passed all production tests—then, and only then—the job is considered complete.

Plant Testing of Materials—If difficulties arise in any production step, the Materials Engineering Dept. checks the materials to determine where the fault lies.



The complex, but efficient set-up of the Westinghouse Materials Engineering Dept. is shown in its organization chart.

Selling Products—In some instances the Materials Engineering Dept. is convinced that some process is better suited to a manufacturing division than the process being used. When this situation arises, the department might serve temporarily as a supplier of parts or components and sell them competitively to the manufacturing unit.

Consult with Other Materials Engineers—When problems beyond the scope of the Materials Engineering Dept. in other plants arise, those problems are sometimes turned over to the East Pittsburgh department in an attempt to find the answer.

Supply Information to Specifications Department—Specifications are arrived at in many ways, and one of the bases on which specifications are built are recommendations and reports of the Materials Engineering Dept.

Establish Properties for Standards—In selecting materials for given products, the Materials Engineering Dept. establishes what properties are needed and the extent of these properties.

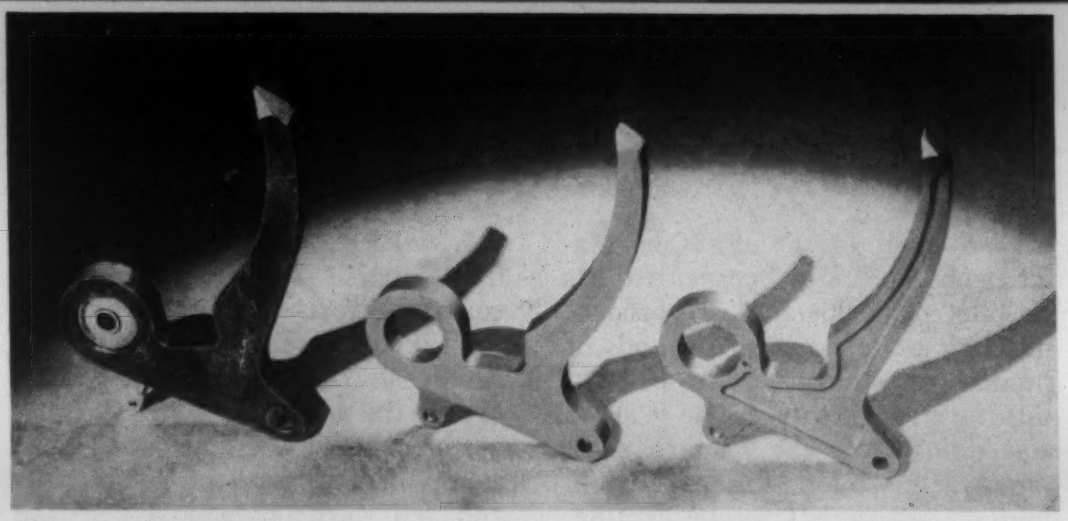
Furnish Materials Engineers for Plants—The wide experience gained in the East Pittsburgh Materials Engineering Dept. serves as a training ground for younger engineers, many of whom later take over as divisional or plant materials engineers.

When the Materials Engineering Dept. is called upon to help the materials department of an outside plant, there is no compulsion to accept its findings. The local department has the final word and responsibility over its own activities.

Typical Jobs Accomplished

Here are some jobs the Materials Engineering Department has handled in recent years. They will serve to illustrate how the department makes itself valuable to the entire corporation.

When aluminum bus bars came into extensive use, difficulty was encountered in making joints or connections with other materials. As an answer to the problem, the department found a practical method of silver plating the aluminum. While the process was being proved, the department did this work on a pilot plant basis and sold its production to the using department. The process saved considerable labor and much silver.



When the Department started its own precision casting foundry, it looked for likely parts to be made by the method. An example is this switchgear lever. First, it was cut from plate; next, with only minor changes it was precision cast; finally, it was redesigned for precision casting. The final product was better looking and less expensive.

When it appeared desirable to selectively silver plate ends or selected areas of copper bus bar for subsequent joining, it also seemed important to perform this operation right in the production line. The Materials Engineering Dept. developed a new process for spot silver plating which was capable of handling long bars and which selectively plated local areas for bolting. Then, in order to assure quality plating with a minimum of technical supervision, a program was established whereby after use for a specific number of hours, the solutions are returned to the materials engineering lab for renewal.

Several years ago the Materials Engineering Dept. devoted much effort to the development of oriented magnetic materials. The materials looked promising but results were erratic. Therefore, the department proceeded to establish processing techniques to provide good and consistent results. But this was only the first step. Next the department studied ways of using the materials, which resulted in the well-known C-core design.

Discaloy, which has received considerable attention in recent years, was developed and is manufactured by the Materials Engineering Dept. As is the case with many titanium hardened materials, Discaloy showed erratic behavior in manufacture. After means of making sound ingots were established, the Materials Engineering Dept. developed working methods for fabricators. Now Westinghouse makes the ingots and ships them to establish fabricators for conversion into final shapes.

When the department notices that some materials are being ordered with unnecessary specifications, it suggests changes which lower costs. For example, some sheets are ordered leveled when the end use does not require the extra mill operation. When the department learns of such a condition, it suggests to the buying and using department that money can be saved by changing the specification.

When the costs of purchased electrical contacts seemed to get out of hand at one point, the department prepared to make them. The result was a lower price from suppliers.

During the past war, the department developed a new material which, in turn, made possible a method of winding generator field coils that did a better job in less time than previous methods. Adoption of the method saved over $90,000 on one type of product alone.

Working with Other Departments

As mentioned previously, the Materials Engineering Dept. works with many other groups within Westinghouse. The departments and functions include purchasing, standards, production and design. Perhaps the closest and most frequent cooperation is between the Materials Engineering Dept. and the various design sections in the company.

At Westinghouse the engineer in charge of a product has complete responsibility over the materials used in that product. Although it is not compulsory for him to use the services of the Materials Engineering Dept., he usually does unless he happens to be working with a material with which he is thoroughly familiar. In some cases, the project engineer will tell the materials engineer that he plans to use a certain material for a certain application. Under other circumstances, the materials engineer will be asked to recommend a material for an anticipated product.

In the first instance, the materials engineer will study the job and report on whether the proposed material is satisfactory or not. If not, an alternate will probably be suggested. When asked to choose a material, the materials engineer will study the job thoroughly and then recommend one material or a choice which will best meet requirements. As part of the materials recommendation, the engineer will suggest any changes in production procedures which might be necessary.

The Departmental Set-Up

The Materials Engineering Dept. in Westinghouse has been under the direct responsibility of a vice president of the corporation, with Mr. Seastone as engineering manager and operating head. Under Mr. Seastone and his assistant engineering manager, L. R. Hill, are the following engineering divisions: The Materials Laboratories; The Metallurgical Engineering Div.; The Magnetic and Insulation Engineering Div., and a small sales group.

To break down the organizational set-up still farther, let's examine the metallurgical engineering division more closely. Under the direction of Mr. H. C. Amtsberg, manager, there are the following sections: Metallurgical Application Section, which operates a special metallographic laboratory and has both ferrous and nonferrous sub-sections; Metallurgical Development Section, which operates the heat treating laboratory and powder metallurgy laboratory operations and handles special alloy development; the Precision Casting Section, which covers process development and a precision casting laboratory and pilot plant; and the Alloy Development Pilot Production Laboratory.

Comprehensive reports are made on all work done in Materials Engineering. The reports cover both work undertaken on the department's own initiative as well as investigations conducted for other departments and manufacturing divisions of the company. The most important information is circulated among interested people throughout the entire Westinghouse organization by means of an internal publication.

All in all, the organization of the Westinghouse Materials Engineering Dept. is such that it could serve as a pattern for any other company, large or small, that is contemplating such a department. Naturally, variations of the set-up would be made in accordance with the needs of the company, but the objectives and philosophies which guide the Westinghouse group could be adopted in their entirety.

Cellular Rubber Insulates, Seals and Cushions

by PHILIP O'KEEFE, Associate Editor, Materials & Methods

Latex foam, sponge and closed cellular rubbers are available in sheet, strip, molded and special shapes and provide a wide range of properties to fit a variety of applications.

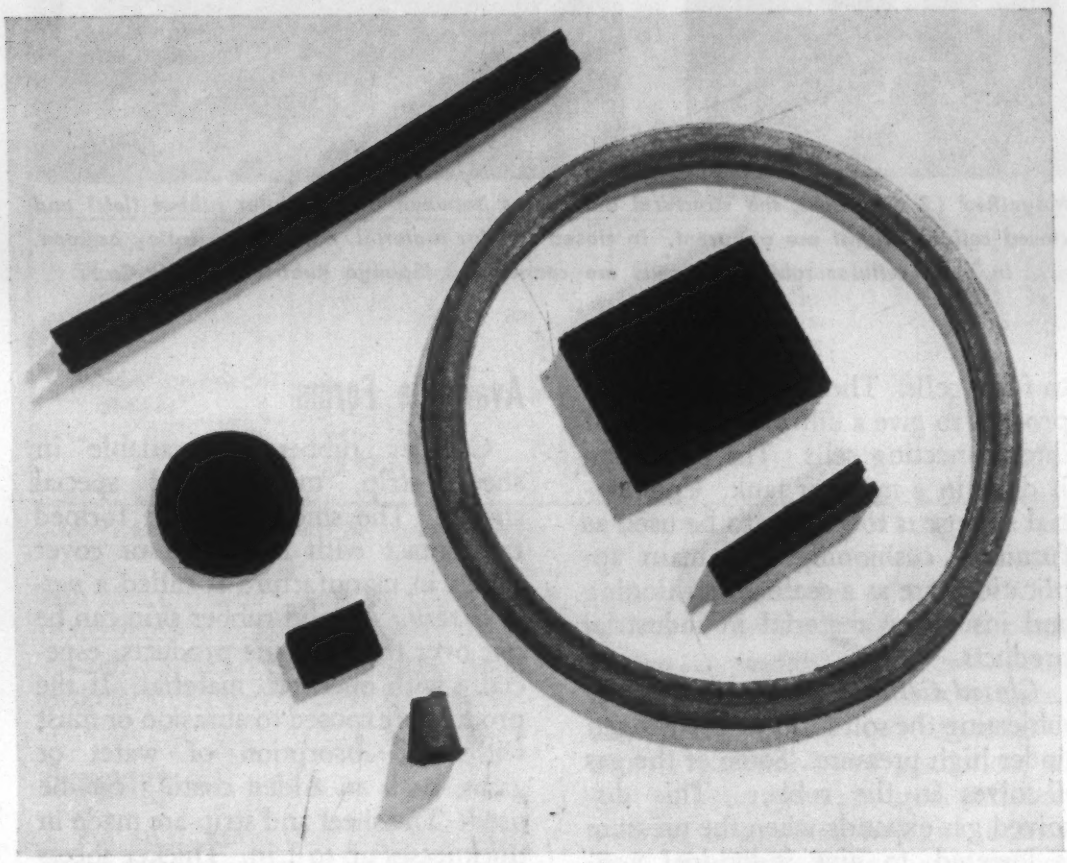
● CELLULAR RUBBER IS gaining increased recognition as an engineering material in its own right. It provides insulation against shock, vibration and sound, and prevents the passage of air, liquids and heat. Many kinds of rubber and several distinct forms of the product itself are available. To take full advantage of the possibilities of cellular rubber in product design and manufacture, the engineer should have a general knowledge of these mutations and families.

Types

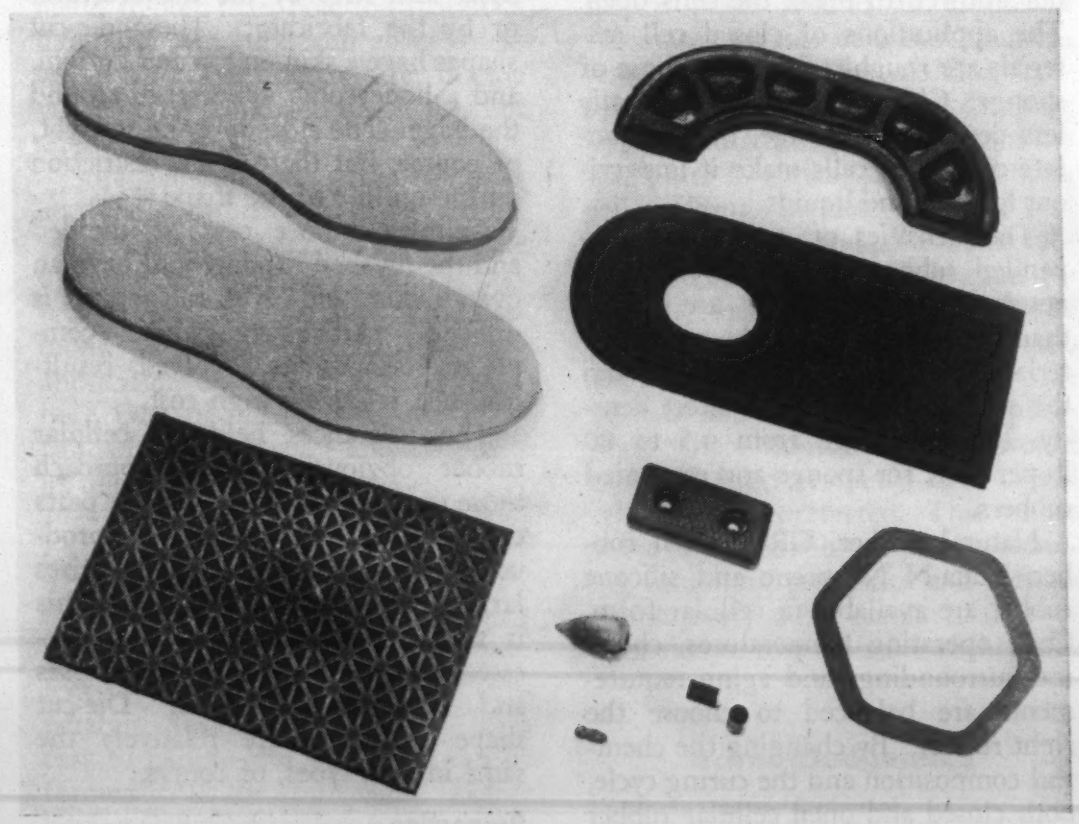
Cellular rubber contains cells or small hollow receptacles. These cells can be either closed or open and interconnecting. Any rubber—natural, reclaimed or synthetic—can be used. The three types of cellular rubber used commercially are latex foam, sponge, and closed cellular rubber.

Latex Foam is made by mechanically whipping up or chemically blowing liquid latex rubber. The result is a network of open or interconnecting cells. The surfaces are all porous. Latex foam is a very soft material, and is used for upholstery, mattresses and general cushioning. Automobile seat cushions are made of latex foam, for example. Latex foam is about 98% air, which makes it much lighter and yielding than the other cellular rubbers. This softness limits its use in industrial products.

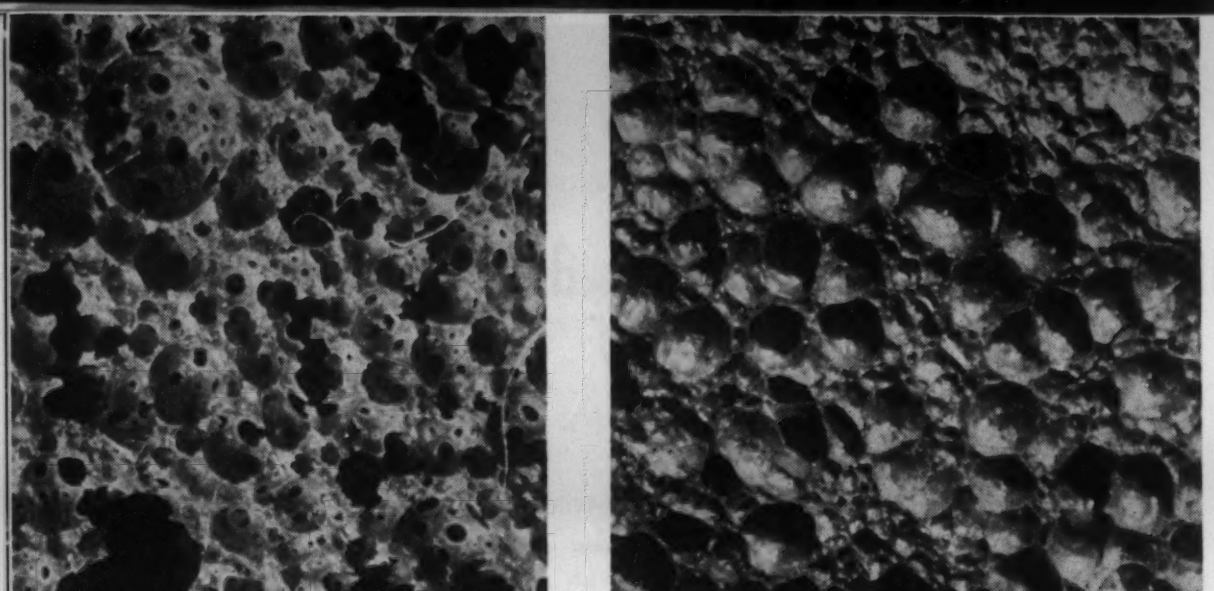
Sponge Rubber, or open cell rubber, is made by putting an inflating compound into the solid rubber before it is vulcanized. This inflating material gives off a gas, which expands



A number of open cellular parts are used in the Soundscriber Corp. Tycoon dictation machine. These parts protect the mechanisms and prevent transmission of noise to the recording disk. (Sponge Rubber Products Co.)



Typical products made from open cellular molded and die cut material are a bath mat, shoe soles, a cushioning pad and gaskets. (Rubatex Div.)



Magnified 12 diameters, the structural differences between open cellular rubber (left) and closed cellular (right) are apparent. In closed cellular material, each cell is a tiny balloon. In open cellular rubber the cells are connected. (Sponge Rubber Products Co.)

to form cells. These cells burst in the process, to give a uniform structure of interconnecting cells. The expansion is done in a mold or tank. Commercial sponge is too heavy to be used as furniture cushioning. Its main applications are as a sealing, cushioning and insulating material in industrial products.

Closed Cellular Rubber is made by subjecting the solid rubber to nitrogen under high pressure. Some of the gas dissolves in the rubber. This dissolved gas expands when the pressure is lowered, to give individual nonconnecting gas cells. These cells can also be made by using gas-forming ingredients. In either case, the gas is not allowed to break the cells open. The applications of closed cell materials are roughly similar to those of sponge. Closed cell rubber is usually less dense than sponge, but its noninterconnected cells make it impervious to gases and liquids.

The densities of sponge and expanded rubbers vary widely. Thinner sections and sheets are denser than thicker pieces of the same material. The type of rubber used and the service required also affect density. Figures range from 4.5 to 80 lb per cu ft for sponge and expanded rubbers.

Natural rubber, GR-S, butyl rubber, Buna-N Neoprene and silicone rubber are available in cellular form. Cost, operating temperatures, chemical surroundings and aging requirements are balanced to choose the right rubber. By changing the chemical composition and the curing cycle, both closed and open cellular rubber can be made soft, medium, firm or bone hard.

Available Forms

Cellular rubber is available in sheet, strip, molded and special shapes. The smooth surface formed by contact with the mold or cover plates in manufacture is called a *natural skin*. A solid rubber skin can be put over this in some products, especially with open cell material. If the product is exposed to abrasion or must withstand absorption of water or gases, such an added coating can be used. The sheet and strip are made in thicknesses up to 1 in. Thicker sheets can be made by cementing several standard pieces together, however. Die-cut shapes are punched out of sheet and strip by the manufacturer or by the fabricator. These die-cut shapes have a skin on top and bottom, and a honeycomb appearance around the edge. The sides must be straight, of course, but there is no restriction on the outline of the shape.

Cellular rubber can be molded and the finished product will have an overall skin. However, the process is difficult, particularly where complicated shapes are involved, resulting in a relatively high cost.

The tolerances held on cellular rubber obviously cannot approach those used with metals. Die-cut parts can be held closer than molded products. Closed cell rubber requires larger tolerances than open cell. This is a matter of manufacturing processes, and holds for sheet thicknesses and molded dimensions. Die-cut shape tolerances are relatively the same in both types, of course.

Properties

The physical characteristics of a cellular rubber are determined by the structure (open or closed cell), the density, the hardness of the rubber, and the type of rubber used. The chemical resistance and low temperature properties and aging resistances depend mainly on the type of rubber. Closed cell material has somewhat better resistance to aging, however, since the cells are filled with nitrogen and air does not come in contact with the interior of the material. Cellular rubbers are usually classified according to compression-deflection, aging, compression set, low temperature resistance, and water absorption characteristics. Special requirements as to oil resistance, tear strength, impact resistance and weathering characteristics can also be used.

The chemical properties of open and closed cell materials are generally equivalent. The water absorption of the closed cellular rubber is extremely low, however, while sponge tends to soak up moisture. Due to its balloon-like structure, closed cellular rubber offers considerably greater cushioning and deflection resistance for a given weight and type of rubber.

Gasketing and Sealing

One of the most important engineering uses of cellular rubber is in seals and gaskets. These gaskets and seals are applicable where the pressure is not large. Like any gaskets, they keep out moisture and dirt. In many applications, the gasket is also designed to prevent rattles and cushion out vibrations. In comparison with other gasketing materials, cellular rubber gives a tight seal with low pressures. Compounds have been developed which do not score or craze plastics. Large dimensional tolerances can also be taken up by these gaskets, and plastic and glass parts can be tightened down to a good seal with very little danger of breaking.

All grades of natural and synthetic rubber, in various hardnesses, are used for gasketing. Both open and closed cell gaskets are used. Die-cut gaskets are cheaper and more dimensionally accurate than molded parts and should be used if possible. Closed cell is preferred where moisture absorption is critical and when there will be a pressure differential between the outside and inside of the seal. Solid rubber skins on cord, strip and molded open cell gaskets are commonly used to decrease the moisture absorption, however.

Drain seals and cabinet door gas-

kets are made of open cell rubber. Specially molded open cell cord with an artificial skin is used in automobile door seals. Neck seals for iron lungs are also made of soft, open cell rubber. A plastic infant incubator top rests on a seal of closed cell material, and closed cell strips act as insulating, mounting and sealing components around the core of an automobile heater. Closed cell gaskets are used on an automobile tail light to prevent breakage of the lens in assembly and keep out dirt and moisture in use without damaging the lens plastic.

Cushioning

Shock absorption, damping, and sound and vibration insulation are also important applications. The resiliency and impact absorbing qualities of cellular rubbers are the selling points here. These materials are soft, light, sanitary and vermin proof. In clamping and holding applications, cellular rubber is soft enough not to damage fragile materials like wire insulation and glass. In clamping and cushioning pads, cellular rubber also has the valuable property of holding objects by its high surface friction, without too much pressure.

All kinds of rubber are used in both open and closed cell form. The closed cell has better shock absorbing qualities on a weight basis, however. In aircraft applications, though, the engineer should remember that closed cell material swells as the outside pressure decreases. Open cell has no tendency to swell, and is often preferred for this reason.

In a recording machine, open cell rubber is used for the turntable cushion, the amplifier insulator, hand microphone spacers, the amplifier gasket and motor shock absorbers. Handling shocks are cushioned out to prevent damage to the delicate mechanisms, and unwanted vibrations are isolated to keep extraneous noise out of the recording. The same material is used to line electrical wiring clamps and as a base for a floor sander and polisher. Portable motors that run on open cell rubber pads are less noisy and do not tend to move on flat surfaces. Closed cell material is used in athletic equipment padding. In spite of its altitude swelling characteristics, closed cell rubber is also used to cushion fuel cells in fighter plane wings. Its nonabsorbent qualities are valuable here. Shoe soles are another cushioning application of closed cell rubber. Automotive uses include arm rests, battery supports, license plate lamp mounting brackets, lamp gaskets, steering post gaskets, cowl gaskets and other anti-squeak pads.

Suggested Tolerances on Dimensions of Cellular Rubber Products

	Thickness, In.			Length and Width, In.		
		Tolerance			Tolerance	
	Dimension	Plus	Minus	Dimension	Plus	Minus
SPONGE RUBBERS						
Sheet and Strip						
	1/8 and under	1/64	1/64	6 and under	1/16	1/16
	Over 1/8 to 1/2, incl	1/32	1/32	Over 6 to 18, incl	1/8	1/8
	Over 1/2	3/64	3/64	Over 18	1/4	1/4
Molded or Special Shapes						
	1/4 and under	1/32	1/32	1/4 and under	1/32	1/32
	Over 1/4 to 3, incl	1/16	1/16	Over 1/4 to 3, incl	1/16	1/16
				Over 3 to 6, incl	1/8	1/8
				Over 6	1/4	1/4
EXPANDED RUBBERS						
Sheet and Strip						
	1/8 to 1/2, incl	1/16	1/16	6 and under	1/4	1/4
	Over 1/2	3/32	3/32	6 to 12, incl	3/8	3/8
				Over 12	3%	3%
Molded or Special Shapes						
	1/8 to 1/2, incl	1/16	1/16	6 and under	1/4	1/4
	1/2 to 1 1/2, incl	3/32	3/32	6 to 12, incl	3/8	3/8
	1 1/2 to 3, incl	1/8	1/8	Over 12	3%	3%

Adapted from American Society for Testing Materials

Buoyancy

An application that becomes more important as military production increases is floats. Open cell rubber is not used here, because of its water absorption. Closed cell rubber can be made lighter than flotation materials like balsa and cork, and absorbs less water and has longer life in the water. Unlike inflated floats, it is not affected by punctures.

Soft materials are used in life jackets, where the article must be flexible. Hard rubber is expanded to make lighter materials, however, and is preferred for life preservers and pontoons. A carburetor float is another application of hard, closed cell rubber. One disadvantage of hard expanded rubber in some applications is its relative brittleness, however.

Insulation

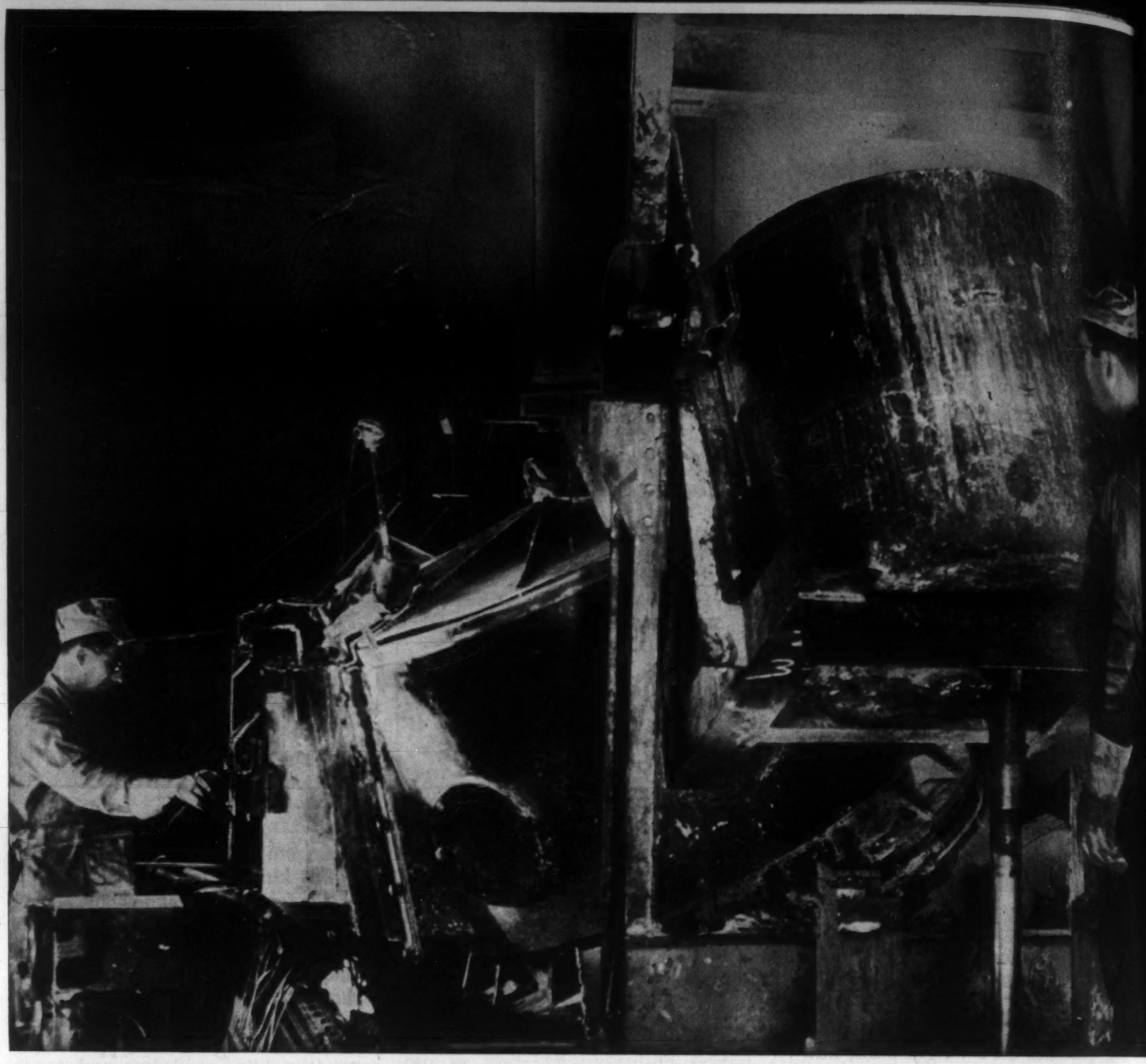
Cellular rubber is light and filled with air cavities. It is thus an excellent room temperature and low temperature insulating material. It is easy to handle and shape and can be formed to fit the application. Beside having an extremely low heat transfer coefficient, it does not pack down like fiber insulators, and resists deterioration from moisture.

The kind of rubber used depends on the temperature and chemical conditions. Because of its low moisture absorption, closed cell material is usually preferred for insulation, although both types are used. Most insulation is supplied in rigid form, at least for large area applications. Small moldings and door gaskets are made soft, however.

A custom molded soft open cell insulator snaps around an expansion valve used outside of a low temperature apparatus. The molding prevents frosting, sweating and dripping by insulating the cold metal from the warm air. In a water cooler, soft open cell moldings insulate regulator and water valve caps and cold water tubing. In addition to being good insulators, these moldings are easy to install. In railway refrigerator cars, refrigerator door gaskets, dry ice bunkers and other insulating applications where moisture pickup would seriously affect economy, hard closed cell rubber is preferred. This can be made light enough to show outstanding insulating properties and outlasts almost every other commercial insulator due to low moisture absorption.

Acknowledgments

Lester S. Cooper, Consultant
Firestone Industrial Products Co.
B. F. Goodrich Chemical Co.
Rubatex Div., Great American Industries, Inc.
Sponge Rubber Products Co.



The holding furnace, into which the molten brass is poured, mixes the charges and feeds the mold continuously.

Better Brass Mill Products Produced by Continuous Casting

Continuous-cast brass mill products show outstanding chemical uniformity and structural soundness. These qualities give important advantages to the fabricators and users of brass products.

by EDWARD L. WOLFF,
Superintendent of Casting Shop, Development & Engineering,
and FREDERICK M. BARRY,
Director of Metals Research Dept., Scoville Manufacturing Co.

● PRACTICALLY ALL METAL forms, from fine wires to box girders, trace their production ancestry back to a casting. This original casting might have been called a pig, an ingot, a slab, a billet or a bar. The soundness of the original casting controls, to a large degree, the quality of the finished material. Flaws in the casting will show up in the end product —even after rolling, extruding or drawing.

Continuous casting minimizes such flaws. The result is that mill products made from continuous-cast brass are sounder and more uniform than products made from individual-cast bars or billets. Continuous casting gives chemical uniformity, with minimum variation of alloying elements between lots. Impurities are also kept to a low level, and there is no segregation of elements, compounds or phases. Inherent soundness in continuous-cast products is ensured by the uniform cast structure. There are no damaging sub-surface blisters,

spills or dirt, and porosity in the metal is eliminated. The absence of intercrystalline shrinkage also adds to the soundness of continuous-cast metal.

The Scovill Manufacturing Co., Waterbury, Conn., now operates two continuous casting machines. One produces brass bars; the other casts billets. The bar machine handles gilding metal (95% copper), commercial bronze (90%), red brass (85%), cartridge brass (70%) and yellow brass (65%). These bars are processed into strip and sheet specialties in coil and flat forms. The billet machine makes billets of from 7- to 10-in. dia for subsequent hot extrusion. Billets are extruded into high-speed brass rod (free cutting), cold heading wire (cartridge brass 70%), phosphorized admiralty condenser tube, and standard forging brass.

The gate-end defect and waste is eliminated in continuous cast billets.

Development History

The advantages of continuous casting from a production standpoint were recognized 100 years ago. Ferrous and nonferrous producers also agree on the quality advantages of continuous-cast metal. The problem has been to design a successful continuous casting machine. The basic apparatus necessary is fairly simple. But any practical caster or metallurgist will appreciate the wide-open opportunity for endless possible difficulties in connection with porosity, shrinkage, skin breakage and grain structure variations inherent in this continuous casting concept.

The first practical solutions were worked out by Siegfried Junghans of Ulm and Stuttgart in Germany before World War II. Junghans tested every conceivable variation in mold design, pouring speed, temperature and cooling technique. Before World War II, continuous casting machines were installed in plants of several German brass and aluminum producers. All of these machines were commercially successful. Aluminum billets up to 20-in. dia and cartridge brass bars up to 29 by 4 in. in cross section were cast. Junghans even went one step further. In his own plant he set up a continuous casting machine with heavy reducing rolls to work the hot metal as it came from the mold.

Hundreds of other enthusiastic approaches have been made to continuous casting. Only two have achieved real commercial stature. The Williams process is being developed jointly by the Republic Steel Corp. and the Babcock & Wilcox Tube Co. The Rossi Process, used by Scovill, is now in full-scale commercial operation in the United States and England on machines installed by the Continuous Metalcast Co., Inc.

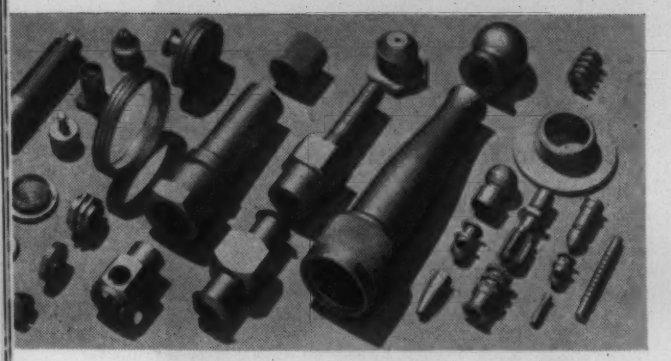
The Rossi machines essentially climax the development work begun in Germany. The Junghans machine imported from Germany by Scovill in 1938, while already successful in principle, was a long way from meeting American standards for production efficiency. Top output was in the neighborhood of 7700 lb per hr, and the molds were limited to the production of 7½-in. dia round billets. In contrast, the Rossi bar machine now in operation in the Scovill casting shop has a capacity of 30,000 lb per hr. Since 1938, this machine and its billet casting counterpart have produced about ½ million tons of sound, uniform metal at Scovill.

Mill Products

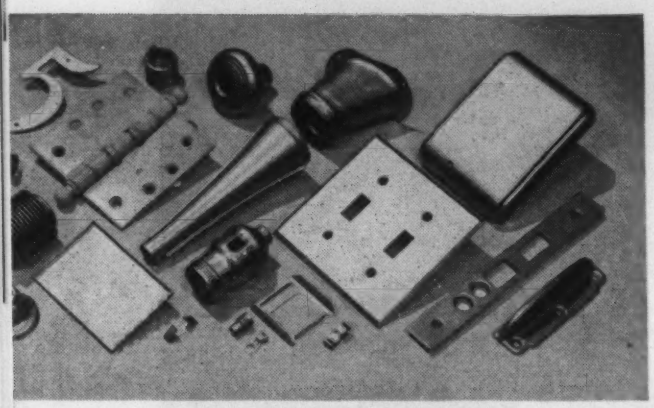
The Scovill brass mill products now being made from continuous-cast billets and bars are free-cutting rod, machinable forging rod and tube; cold heading wire, strip, sheet and condenser tube. The chemical uniformity and structural soundness of the brass give important application and fabricating advantages to users of each of these products.

High-speed brass rod (free cutting) is furnished in half-hard temper and a variety of special tempers for difficult operations. These special tempers facilitate special machining operations such as long forming, outside shaping, extra-deep roll lettering and knurling. Special tempers are also adapted to secondary fabricating operations like bending, spinning, swaging and upsetting. The inherent advantages in all tempers include uniform temper and chemical composition from rod to rod, minimum lead segregation, freedom from extrusion defects, and a smooth, clean, burnished surface. Screw machines cutting this material can be run at the highest permitted speeds with maximum tool life. A maximum number of pieces can be produced per minute, with sharp, free-running threads, smooth, clean surfaces, close tolerances, thin cut-offs and uniform, short chip breakage.

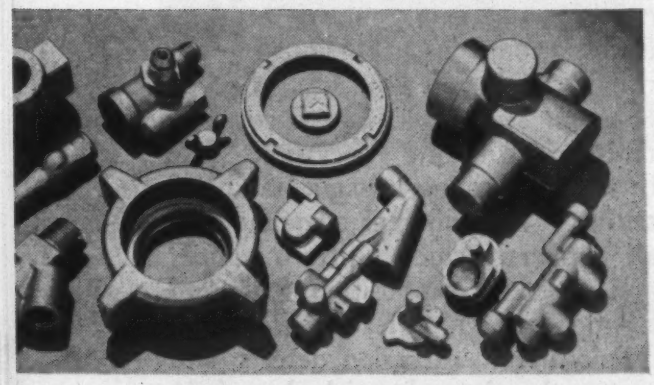
Standard and special alloy forging brass are produced in half-hard temper and in as-extruded and straightened temper. Special forging alloys are designed to meet particular end-use requirements. The following advantages are inherent in continuous-cast forging brass; excellent free-flowing and hot working characteristics; high machinability of the leaded alloys; prime mechanical characteristics; uniform alpha and beta metallographic structure; finely



A collection of products turned from continuously-cast high-speed brass rod. The superior machinability of this free-cutting brass permits high machine speeds and assures long tool life.



Typical drawn-formed-stamped parts made from continuously-cast brass strip and sheet alloys. These materials give long non-stop runs on machines.



Typical forgings and hot pressings made from continuously-cast forging alloys. The good free-flowing qualities of these materials permit varied use of press and hammer capacities at relatively low pressures.

divided and uniform lead distribution in the leaded alloys; wide hot working temperature range; freedom from mill extrusion defects.

Cartridge brass cold-heading wire is furnished in two tempers to satisfy requirements for heading and extruding, and for heading and machining (drilling). Mill finishes are varied to accommodate individual needs. This cold heading wire virtually eliminates such heading defects (due to the wire) as split heads and shanks, out-of-round heads, inadequate filling out of heads and shoulders, and rough, orange-peel effects. These advantages are attributed to the uniform composition, structural soundness and closely controlled temper of wire made from continuous-cast brass.

Continuous cast strip and sheet are produced in cartridge brass, gilding metal, commercial bronze, red brass and yellow brass. All standard annealed and cold-rolled tempers are available. The outstanding advantages of continuous-cast strip and sheet include: huge coils for long non-stop runs; clean, smooth surfaces; minimum tolerance on width, thickness, length and edgewise straightness; uniform composition and temper from piece to piece; freedom from internal defects; close grain size limits; a minimum of mechanical defects such as pits, gouges and scratches. The superior soundness and ductility of the strip and sheet promote maximum tool life, permit extra deep draws and sharp bends, and increase working limits. The uniformity of the material enables machines to operate at the highest permitted speeds with minimum tool adjustments. Machine slow-downs and shut-downs from metal irregularities are held to a minimum.

Phosphorized admiralty condenser tube extruded from continuous-cast billets is outstanding for chemical uniformity. Continuous casting maintains the optimum amount of the inhibitor, phosphorus, for a maximum resistance to dezincification. The uniform chemical composition and temper and the freedom from internal defects, marks and dents gives long trouble-free service.

The Future

When men of imagination see their ideas take practical form with such dramatic results as have been demonstrated in continuous casting, it is only natural that new horizons seem both broad and bright. But in this case, the actual results and advantages from continuous casting may be set down to speak for themselves. The following summarizes the current status, with significant glimpses of the future potential in continuous casting of the basic metal groups—brass, copper, aluminum and steel.

Brass—In brass alloys, the installations at the Scovill Mills have, since 1938, upwards of ½ million tons of metal production behind them. Compared to former traditional casting methods, savings of up to $6.00 a ton have been made, and the dependable quality and high output of the Rossi machines have served as one of the basic reasons for Scovill's $10 million investment in its new continuous cold-rolled brass strip mill.

Copper—The American Metal Co., Ltd., through its subsidiary, the United States Metals Refining Co., Carteret, N. J., has been successful during the past year in the continuous casting of oxygen-free, high-conductivity (O.F.H.C.) copper billets from 6- to 8-in. dia and slabs (cakes) 4 by 13 and 3½ by 26 in. in cross sections on a commercial basis under patents of The Scomet Co., New York.

Aluminum — Aluminum production is another field of tremendous promise for continuous casting. Experimental work has been largely completed, and commercial operation has been going on at the Rossi continuous casting installation in the English plant of Imperial Chemical Industries, Ltd., and James Booth & Co., Ltd. Continued success of this method for production of aluminum billets up to 20-in. dia and slabs up to 10 by 48 in. will offer important production advantages over the multiple mold processes now being used in this industry.

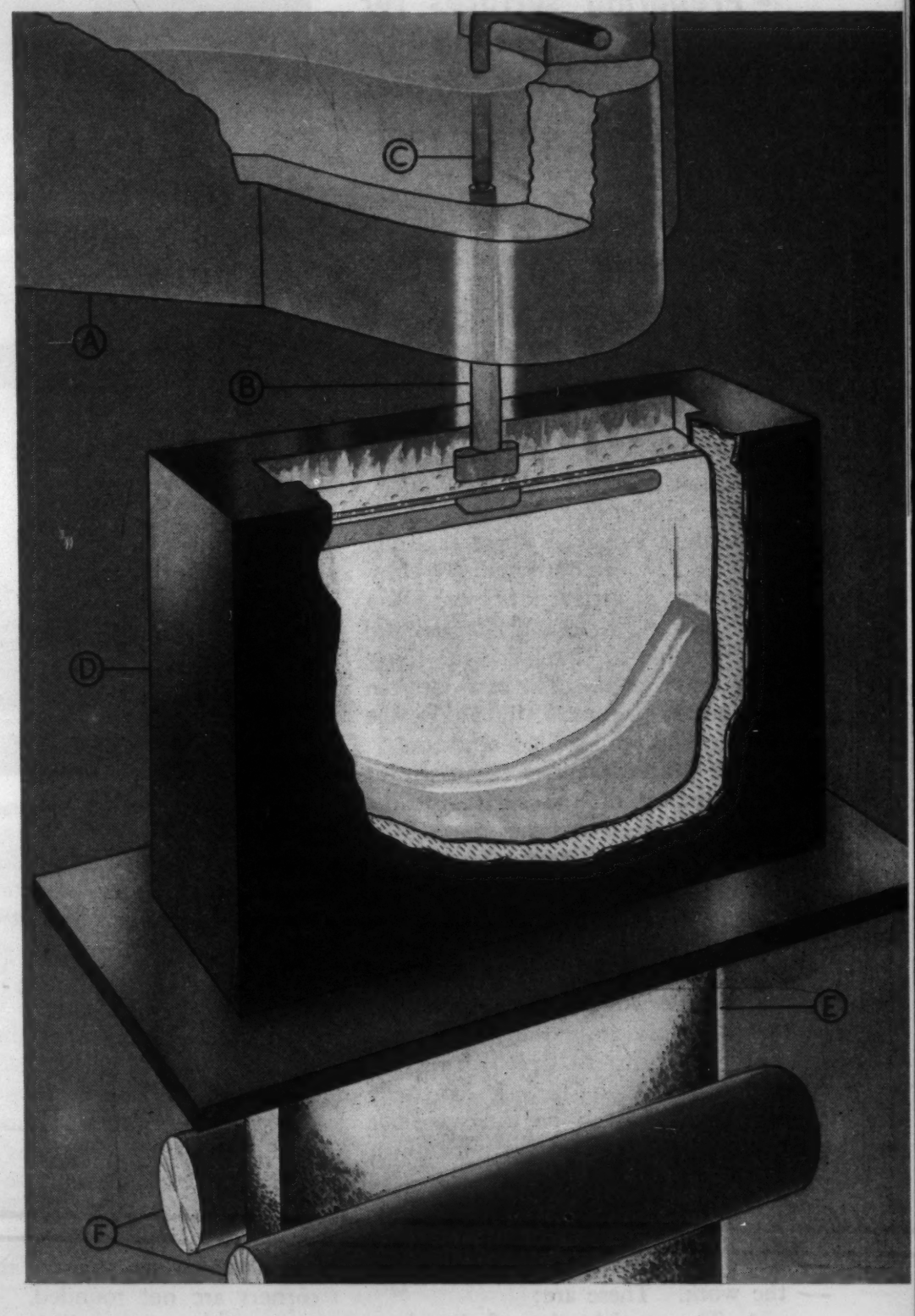
Steel—At Allegheny Ludlum Steel Corp.'s Watervliet, N. Y., plant the casting of stainless steel billets (4½- to 9-in. dia) and bars (up to 3 by 15 in. in cross section) by the Rossi Process has been going on for about 2 years. Metal of such good quality has been produced at such low cost that expansion of the operation is being advanced with all possible speed. A new and larger Rossi Machine is now contemplated for this Watervliet operation. This will be the first commercial-scale continuous steel casting machine in the world.

Photograph illustrating the structure of a continuously-cast cartridge brass bar.

What steel producers can eventually look forward to with full utilization of continuous casting methods and equipment covers a wide range of needs. Ingot pouring, soaking pits and blooming mill operations, with equipment often costing many millions, can be eliminated almost entirely, since continuous casting will produce metal of dimensions suitable for direct feeding to the rolling mill. Obviously, with such a change in capital cost factors, long sought decentralization of steel producing facilities comes closer as a practical possibility.

While the output from continuous casting machines, illustrated and discussed in this article, is in the shape of either round billets or flat bars, the equipment and process is by no means limited to these. Cast hollow shells for the production of tubes are but one example of a shape now in the course of development which has outstanding significance in both ferrous and nonferrous tube producing fields. Even larger and heavier size castings than those discussed are metallurgically practicable. Of course, commercial production of metal requires that the size of castings must be integrated with other factors, such as: (1) capacity of melting furnaces; (2) capacity of mill handling and processing equipment; and (3) capacity of metalworking machines that fabricate mill products.

The Continuous Casting Machine



The latest-type Rossi continuous casting machine and holding furnace unit is designed to handle up to 30,000 lb per hr of brass. Such a machine can be built up through several levels in the casting shop. Despite its vast size and capacity, it requires only ten operating men—four tend the three 20,000-lb Ajax-Scomet melting furnaces, one operates the charging crane, one handles the crane ladle, two operate the casting machine, one tends the cut-off saw and one tends the roller delivery table. Each of the three special high-capacity Ajax-Scomet induction melting furnaces has a capacity of 10,000 lb per hr.

Metal is picked up from each by the 5,000-lb capacity charging ladle approximately every half hour and transferred to the 9,000-lb capacity electrically heated holding furnace (A) at the top of the machine. This holding furnace has two sets of pouring spouts; if one set becomes clogged, the furnace can be revolved 180° on its mount, tipped in the opposite direction, and poured through the duplicate spout. Each of the down spouts (B) is in the form of an inverted T and is designed for the particular metal to be handled. Holes are drilled in the bottom of the spout and it is regulated to keep the metal in the mold at a constant level, with the crossbar of the T submerged. Rate of flow through the downspout is controlled by the operator by means of a specially designed needle valve (C).

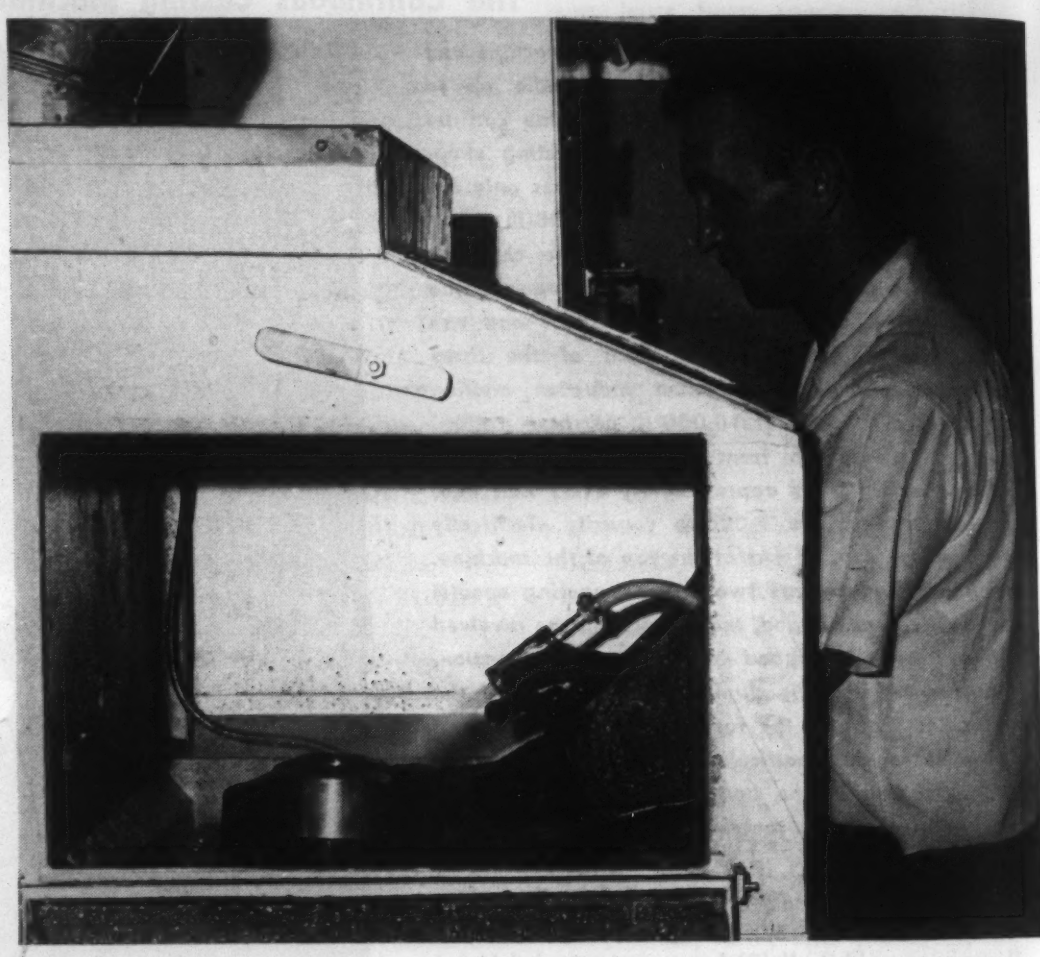
The copper mold itself (D) has a water-cooled jacket and moves up and down with a reciprocating motion. The downstroke of the mold is synchronized with the rate of discharge of the casting and the upstroke is several times that rate. The slab or billet (E), as the case may be, changes from molten to dull red solid condition as it passes through this moving mold and is continuously brought down at controlled constant speed by a pair of withdrawing rolls (F). Immediately below the rolls and mounted on a traveling elevator-type platform is the horizontal circular cut-off saw. When the billet or bar has been brought down to required length (usually from 2½ to 10 ft), this saw is automatically advanced to cutting position, and while cutting, travels down with the moving casting. The cut section descends into a carrier and is automatically lowered and delivered to conveyor tables for removal to the stockpile or immediate use. One of the Scovill continuous casting machines delivers a 7¾-in. dia, 31½-in. long billet every 2 min. The continuous bar casting machine produces a 2200-lb flat slab 25½ in. wide by 2½ in. thick and 10 ft long about every 6 min.

Wet Blasting Performs Many Cleaning and Finishing Operations

by JOHN L. EVERHART, Associate Editor, Materials & Methods

Blasting with an abrasive suspended in a liquid provides a rapid and economical method of:

- ***Preparing surfaces for plating and coating***
- ***Finishing molds and dies***
- ***Removing oxide coatings***
- ***Deburring***
- ***Descaling***



Wet blasting is a flexible means of surface cleaning. (Cro-Plate Co., Inc.)

● LIQUID IMPACT BLASTING, liquid honing, or wet blasting, as the process is variously called, has shown its versatility in many cleaning operations. The method has been in use for only a relatively short time but has already demonstrated its efficiency for a variety of jobs. Wet blasting saves time and material and is adjustable to obtain a wide range of abrasive effects. The machines can be operated automatically and can be handled by semi-skilled operators.

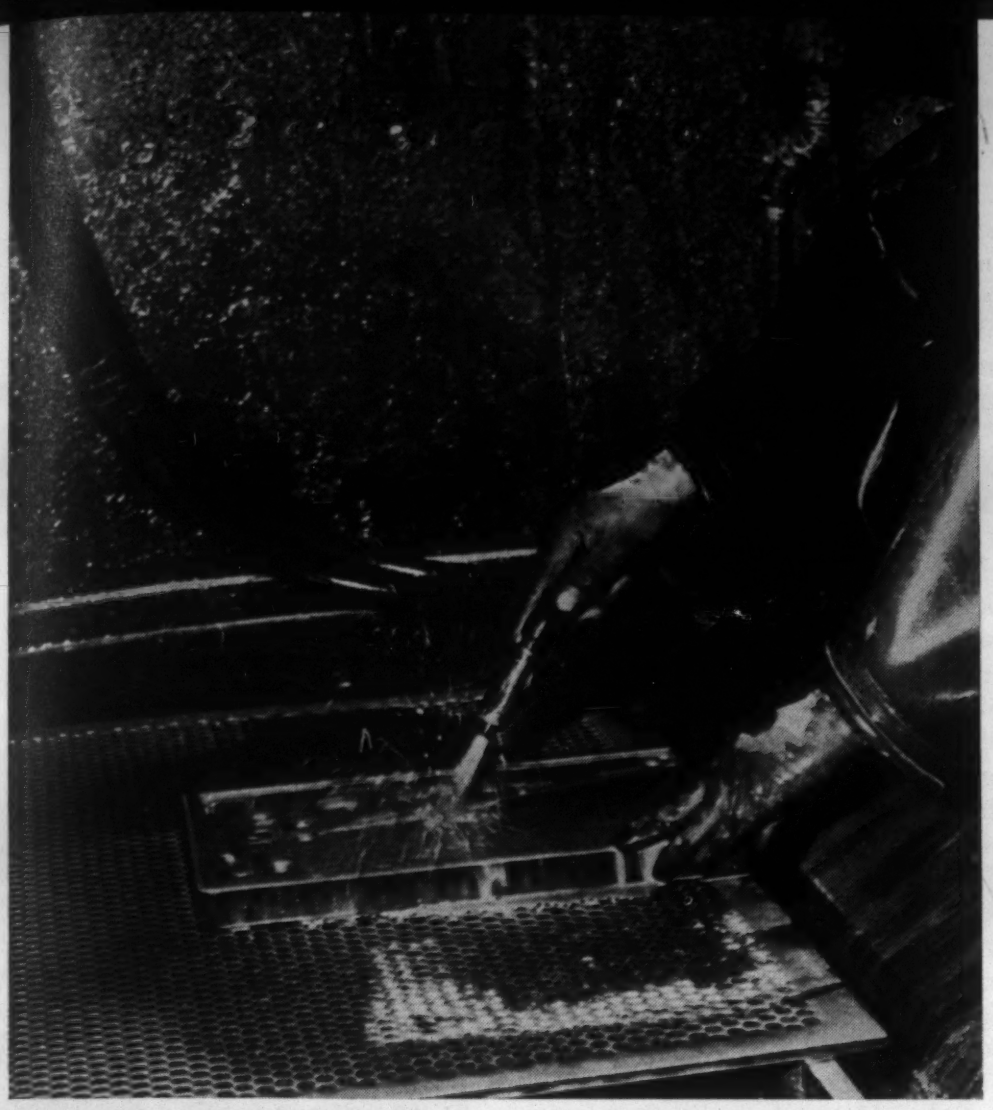
The process consists essentially of the blasting of the surface to be cleaned with a suspension of abrasive in a liquid medium which is usually water. The abrasive is held in suspension and delivered to the spray-nozzle either by low-pressure air or by pumping. It is thrown against the work at high velocity by means of compressed air. Wet blasting is superior to dry blasting for many applications because extremely fine abrasives can be used without danger of packing and a finer finish is obtainable.

Liquid blast cleaning is quite flexible because a number of variables can be changed to suit the nature of the work. These are:

1. The particle size of the abrasive can be varied from 60 mesh to 5000 mesh equivalent.
2. The hardness can be adjusted through the nonmetallic scale from materials as hard as silicon carbide to materials as soft as nut shells or corn husks.
3. The air pressure can be varied over wide limits.
4. The distance from the gun to the piece can be changed.
5. The liquid-to-abrasive ratio in the suspension can be varied.

By suitable combinations of these factors, the process can be used to take off heavy scale or to remove so little material that the dimensions are altered only slightly and sharp corners are not rounded. Fine recesses and corners which cannot be reached by hand can be finished by wet blasting. However, the method will not replace hand-polishing on curved surfaces which the abrasive cannot strike at the proper angle. Although grinding and cutting lines can be blended into a homogeneous surface, a matte finish is obtained and the procedure will not replace fine hand-work with rouge or similar abrasives. The finish obtained depends on the pre-blast finish. Liquid blasting will not make a rough-ground piece smooth enough to do the work of a piece which has been finish-ground, nor will it produce a desired dimension. Parts should be finished to the required size before blasting and blasted with an abrasive fine enough to hold that size.

Ordinarily, parts to be wet-blasted require no pre-cleaning operation. However, heavy grease should be re-



Corners and crevices of intricate dies can be blasted without rounding the sharp edges. (Pangborn Corp.)

moved. After blasting, the parts are usually rinsed in hot water and air dried.

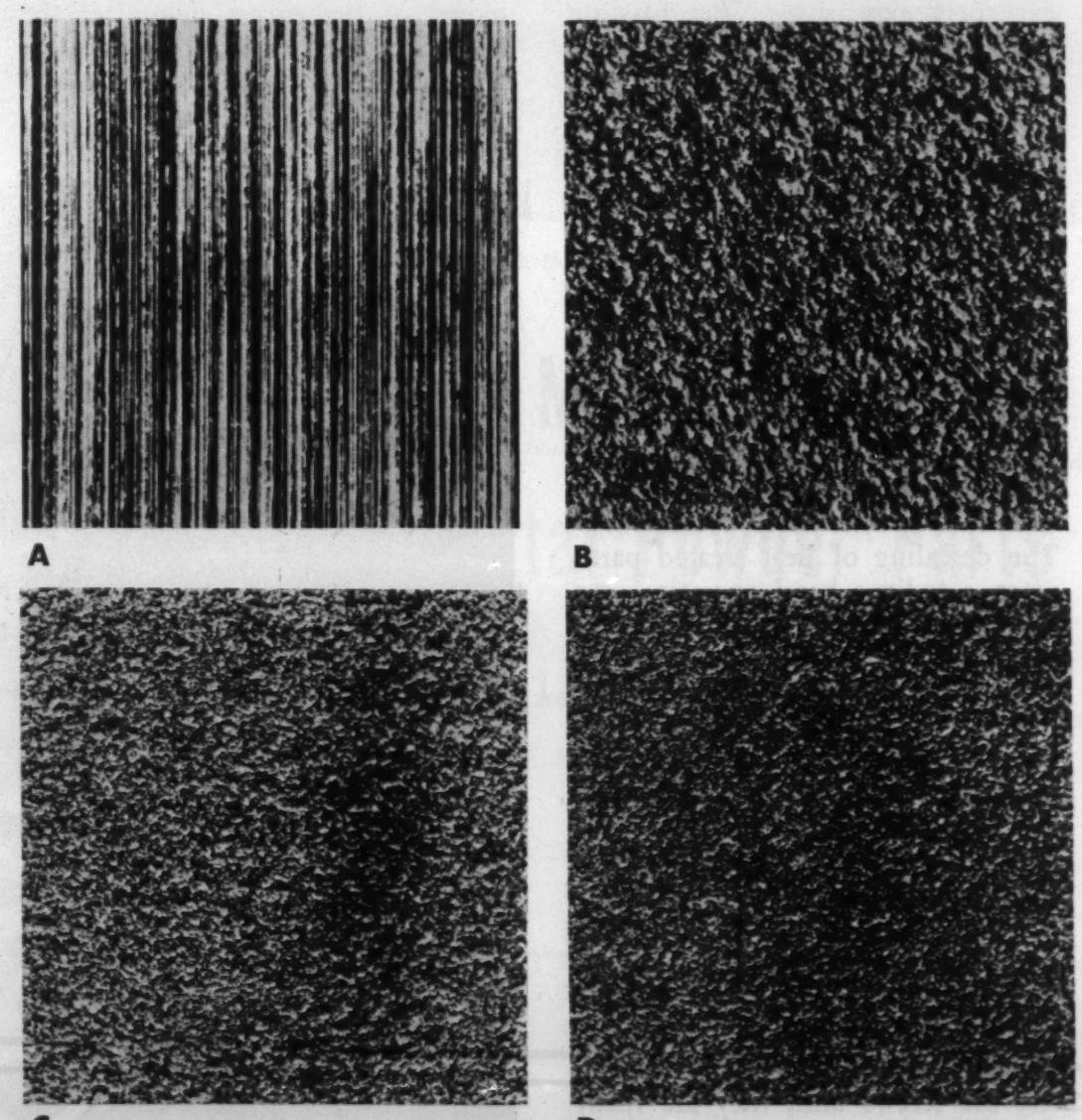
Applications

Surface Preparation for Plating or Coating—At present, the preparation of surfaces for plating is one of the principal applications of wet blasting. Since parts cleaned by this method have a matte finish, intermediate buffing or polishing operations may be required before decorative plating. If such operations are not required, no alkali cleaning is necessary because the blasted surfaces are chemically clean.

Liquid blasting is especially applicable to preparing machine parts for chromium plating intended to improve the wear resistance of the part. The matte finish produced by blasting increases the surface area and at the same time assists in obtaining a tighter bond between the base metal and the deposit. The bonding of paint, rubber, plastic and other coatings to metal surfaces is improved also by wet blasting the metallic surface before applying the coating.

Mold and Die Finishing and Maintaining—In the preparation of new molds, wet blasting can be used to remove the oxidized surface produced during heat treatment, and to remove and blend grinding lines left on the surface of the piece. Since these are often hand operations, cost savings can be quite impressive. To cite an example, it required 1 hr to hand-finish a die insert, used for making a small serrated knob, after heat treatment. This part had many grooves, running from top to bottom, making hand polishing difficult. Using liquid blasting, 16 inserts were finished in less than an hour. Satisfactory parts were produced immediately in the dies finished by wet blasting, while hand-finished dies required considerable breaking-in before acceptable parts were produced.

The matte finish which results from wet blasting is frequently desirable in molds to be used for plastics. Parts produced from polystyrene or Vinylite in such dies have a soft sheen which is not only attractive in appearance but also serves as an excellent base for paints. Molds for Bakelite or polystyrene parts, which require a high luster, are wet blasted before chromium plating to



Removal of grinding lines is accomplished by wet blasting. Surfaces shown in A can be improved with resulting surface a function of the fineness of the abrasive. B shows surface obtained by wet blasting with 100 mesh silica, C by blasting with 325 mesh silica, and D by blasting with 1250 mesh silica 125 times magnification. (Pangborn Corp.)

improve the bond between the mold and the plate.

Equally important with the production of molds is their maintenance after they have been placed in service. Molds and dies used at elevated temperatures in such applications as glass molding, rubber molding and die-casting require frequent attention to remove the carbon and oxide deposits. With liquid blasting, using fine abrasives, the life of the mold is extended considerably since the metal removal in cleaning is held to a minimum.

Deburring of Parts—Wet blasting has been used to deburr extruded gears. A hand operation previously used was not too efficient at the roots of the teeth; the blasting operation proved faster and deburred the root also. In a certain diesel fuel injector holder, the fuel is fed to the nozzle through three small diagonal holes. To insure satisfactory operation, these holes must be free from burrs and lint. Hand cleaning and flushing did not produce a completely satisfactory part and were extremely expensive. Wet blasting has replaced hand cleaning and yields a thoroughly clean and deburred product in a minimum period of time.

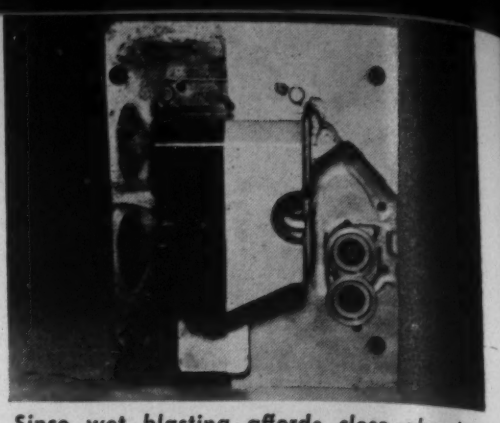
Small shapes, which are difficult to deburr by other means, have been handled satisfactorily by wet blasting. Such parts include hypodermic needles and instrument pen points. However, the process is not confined to metal parts. Molding flash on plastic switch parts, previously removed by hand, is now removed more quickly by wet blasting.

Descaling after Heat Treatment—The descaling of heat treated parts, often a tedious hand operation, can be accomplished by wet blasting in a fraction of the time required for hand work. For some parts, no further operations are required. For parts which must be polished after descaling, one shop estimates that wet blasting saves up to 25% of the polishing time even on work requiring superfinishing.

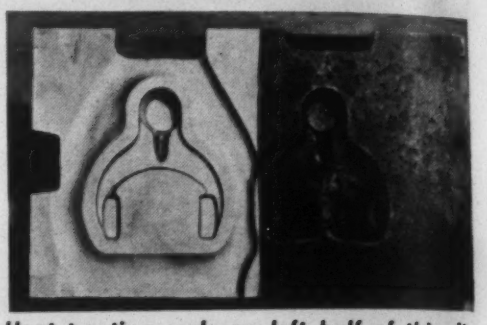
Removal of Coatings—An interesting application of wet blasting for the removal of protective coatings occurs in a plant which produces standard sizes of set-screws. To protect the screws until they are ready for plating, they are blackened chemically. Upon receipt of an order for plated screws, the blackening must be removed. This was accomplished by acid descaling with the accompanying danger of surface pitting, if the operation was not controlled carefully. Changing to wet blasting resulted in more rapid removal of the coating with no danger of pitting.

Finishing and Renovating Tools—Whether the use of liquid blasting extends the life of cutting tools is a matter of considerable controversy. However, in a number of organizations it is claimed that the life of production cutters is extended if they are blasted after grinding. These plants are using the process on complicated cutters such as hobs or broaches. Files wear in service to the point at which the cutting edge no longer functions satisfactorily. The usual method of sharpening has been acid dipping. Wet blasting, which has been substituted for the acid dip in a number of organizations, is much faster and makes possible more recuts, thus extending the life of the file.

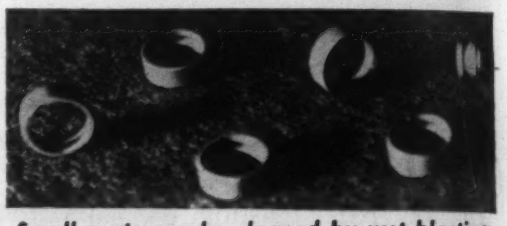
Other Uses—Among other applications of wet blasting are the cleaning of parts for brazing and the removal of the excess flux after the operation, the cleaning of steam turbine blades and ordnance items, and the overhauling of engines.



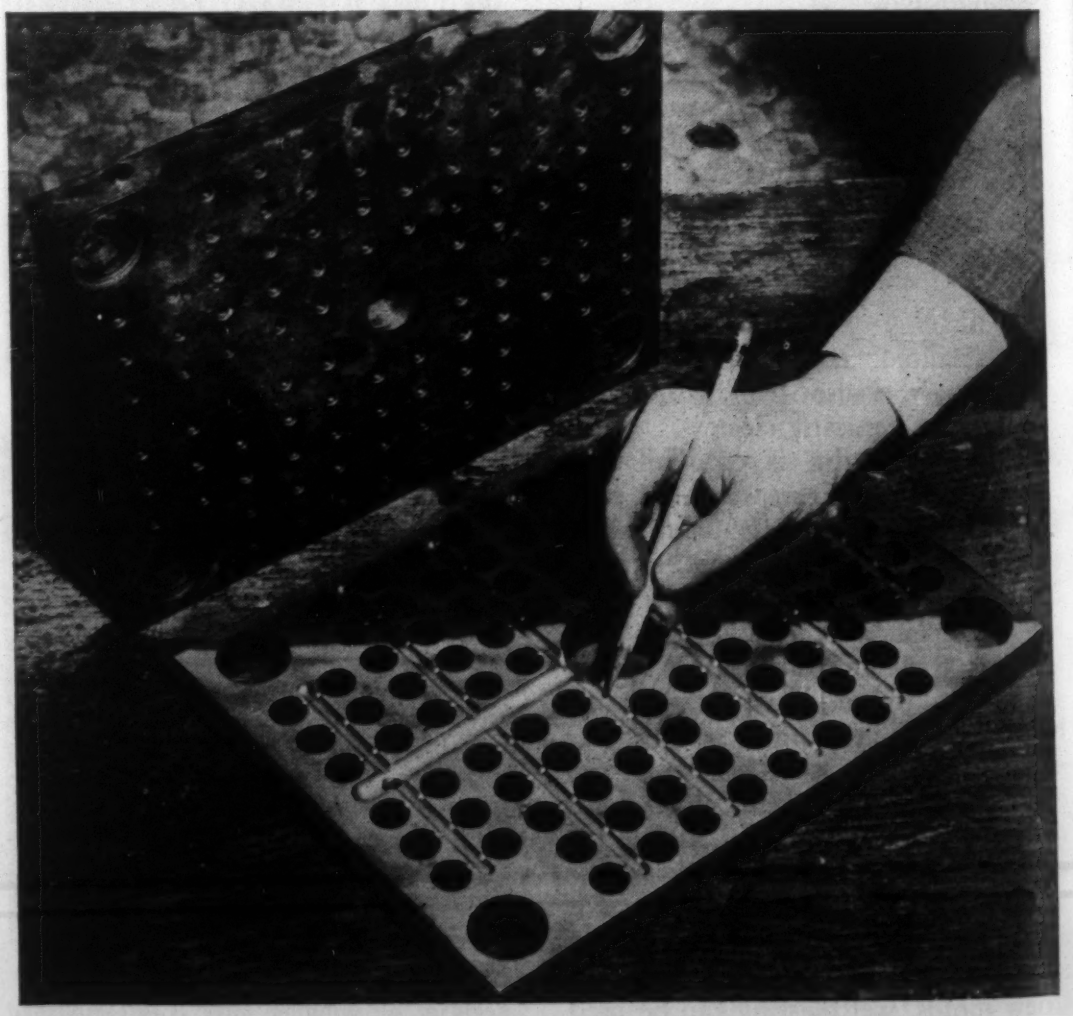
Since wet blasting affords close abrasion control, intricate diecasting dies can be cleaned safely without damage to thin-walled sections. (American Wheelabrator and Equipment Corp.)



Heat treating scale on left half of this die was cleaned in a few seconds using 325 mesh abrasive. (American Wheelabrator and Equipment Corp.)



Small parts can be cleaned by wet blasting as readily as large objects. (Cro-Plate Co., Inc.)



The partially cleaned mold retainer plate shows how heat treating scale can be removed and grinding lines blended. This plate had a hardness of 51 Rockwell C, and only 4 min were required to clean the portion indicated. (Pangborn Corp.)

Equipment for in-plant production must be planned to handle a constant base load, with the over-flow going to custom fabricators.

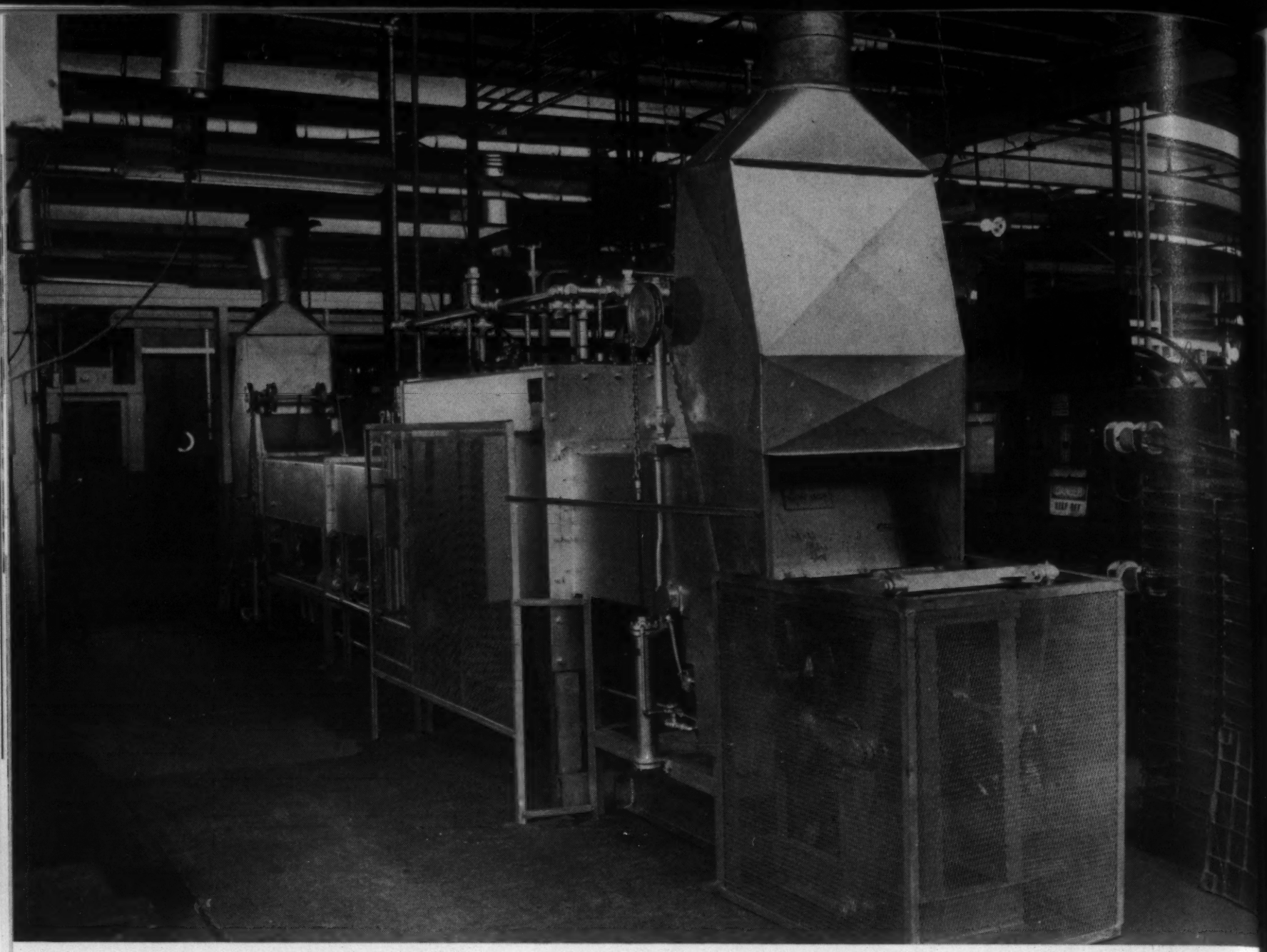
The Plus and Minus of Making Your Own Metal Powder Parts

by **JOSEPH L. BONANNO, Chief Engineer, Lionel Corp.**

An in-plant powder metallurgy department has advantages where constant high volume production is needed, but custom fabricators must still be relied upon to handle overflow, large and unusual sinterings.

● THE PAST FEW YEARS have seen rapid increase in the popularity of the powder metal process for the fabrication of small structural parts. The technology, application and economics of this relatively new process have been widely discussed in recent literature, and numerous examples have been presented to demonstrate the ability of pressed and sintered powder metal parts to replace competitive stampings, die castings, small sand castings and screw machined parts; frequently with such strikingly apparent success that most progressive manufacturers can hardly avoid the application of this process to their own product.

Since compacting presses, sintering furnaces and the rest of the metal powder fabricating equipment involves considerable investment, the manufacturer's first experience with powder metal parts will usually be with those made by a custom fabrica-



A typical sintering oven used in the powder metallurgy department at Lionel Corp.

tor—a specialist in the production of sinterings for the "trade". For most concerns whose requirements are not too great, or are limited to a comparatively few standard parts such as oilless bearings, the custom fabricator is a perfectly adequate source of supply. Other manufacturers, however, will find that increased experience with sinterings suggests even wider fields of application, and as the volume of sintered parts reaches sizable proportions the question eventually arises: How about making these parts ourselves? In general, any manufacturer who has found it profitable to produce his own parts by any of the competing processes will do well to consider the economics of in-plant production of sintered parts as well.

Quite naturally, consideration of possible in-plant production suggests a host of other problems: Under what circumstances is in-plant production of metal powder parts economically sound? What are the advantages of such in-plant production? What are its limitations? What type of personnel and auxiliary equipment is necessary? What about experimental and development facilities?

Probably the most practical way to evaluate the importance of these problems is by considering the experience of those manufacturers who have successfully ventured into in-plant powder metallurgy. One such concern is The Lionel Corp., which in less than half-a-dozen years has developed a large and highly successful powder metallurgy department consuming over a million pounds of metal powder annually.

With an annual requirement of tens of millions of miniature car and locomotive wheels, The Lionel Corp. had the prime pre-requisite for setting up an economically sound in-plant powder metal production unit—consumption of a volume of parts sufficient to maintain continuous operation of the equipment at a high load factor. It should be noted that other concerns who have installed successful powder metal departments have had similar basic loads. Bassick, for example, uses large quantities of caster wheels; Trico requires millions of oilless bearings; and National Cash Register fabricates a variety of small high precision sinterings in large quantities. Ideally, the volume of suitable parts should be sufficient to justify a plurality of presses and furnaces to allow for down time.

Economic Considerations

In considering the economics of in-plant powder metallurgy, particularly as it differs from that of competing processes such as screw machining, stamping or die-casting, it becomes evident that the heavy initial cost of metal powder facilities creates a basic difference in the planning and utilization of equipment and in relation between in-plant and custom fabrication of parts. In screw machining, for example, although the custom fabricated parts are frequently as cheap as rod stock, particularly where re-usable scrap is heavy, it may still be advantageous to maintain stand-by in-plant facilities, utilizing them for short-run jobs, short delivery schedules and production peak over-flow

that cannot be conveniently handled by the custom fabricator. In powder metallurgy, on the other hand, the use of production type facilities for experimental or occasional use only would be prohibitive. Equipment must be planned to handle a fairly constant base load, with the overflow going to custom fabricators. Because of the cost of heavy tonnage presses, in-plant production is also in most cases limited to small parts, with the large parts again being relegated to specialists having suitable equipment.

Tool and Laboratory Facilities

While the establishment of an economically sound powder metal department is predicated on the existence of an adequate production load, its continued successful operation depends vitally on the availability of a properly staffed tool design section and well-equipped tool making and machine shop facilities capable of building the tools, replacing worn or broken parts, and servicing presses, furnaces and auxiliary equipment. It should be kept in mind that, in addition to their exceptionally high service and maintenance needs, powder metal presses frequently require considerable initial tinkering. It is true that a press can be bought fully tooled and ready to produce a bearing or other simple part, but an intricate part necessitates considerable experimental tooling and often conversion or adaptation of the press itself.

The machine shop and tool making part of these requirements should be met without any undue difficulty by any well-rounded manufacturing plant; the problem of tool designing personnel is quite another matter. Unlike other manufacturing processes, powder metallurgy has no standard tooling procedure but requires a high order of ingenuity. The problem is further aggravated by the fact that there has been so little published information and that of such sketchy nature that the powder metal tool designer is left pretty much on his own.

In addition to a machine shop, one of the almost indispensable adjuncts to a powder metal department is a laboratory equipped to control the characteristics of the raw materials, to determine proper mixes and sintering procedures, to check the suitability of experimental parts to the process and vice versa, to prove the design of parts by actually producing them to temporary tools, and to exercise production control of sinterings requiring close dimensions, accurate weights or high physical characteristics. Here, too, the material requirements are of no particular difficulty since the cost need not be excessive, but the prospective in-plant producer should satisfy himself that he has qualified personnel or ready access to services of consultants.

In Lionel's experience, laboratory and experimental facilities have paid off handsomely not only in helping to avoid costly mistakes in mass production runs, but also in producing by means of temporary tools pilot runs of experimental parts difficult or impossible to produce by any other process. Thus, once the department is organized for the production of the base load and the auxiliary laboratory and machine shop facilities are provided, ample opportunity presents itself to explore and exploit other possible conversions to powder metals.

Converting to Metal Powder Parts

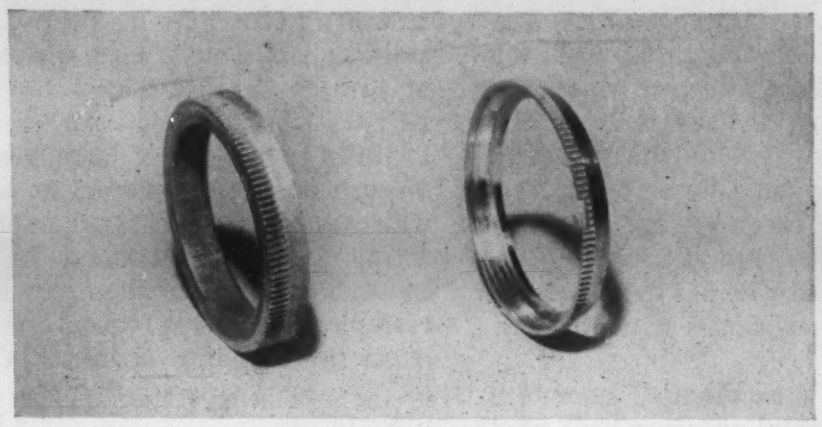
It is this opportunity to experiment, to convert existing parts to powder metal, and to design new parts specifically for powder metallurgy that is one of the most profitable and rewarding aspects of in-plant operations. Therefore, it would appear advisable for any manufacturer contemplating extensive use of sinterings in his product to install pilot facilities such as a hydraulic press and laboratory type sintering furnace and engage in exploratory work even though his immediate economic picture does not justify in-plant production.

Over a period of a half-a-dozen years Lionel's own products have been thoroughly explored for the possibilities of conversion to powder metallurgy. Within the past year a number of government contracts have been taken which proved an amazingly fruitful field for conversion. Those who have experience with government agencies know that permission to change materials and methods cannot be had solely for the asking. In most cases, samples of suggested alternate parts must be submitted to the government agencies for testing. Such samples, furthermore, whether they be die castings, plastic moldings or sinterings, must be tool produced from the same materials and by the same process as the production items, a requirement which, in the case of sintered parts, eliminates machining them from slugs or bars. To eliminate the barrier of "frozen design", Lionel has utilized its laboratory and model shop facilities to produce a large number of such qualifying samples at a cost which is but a small fraction of the savings ultimately effected by the conversion. Some of the outstanding examples of recent conversions to metal powder parts accomplished at Lionel are described in the accompanying box.

One might ask, "Can't all powder metal conversions be accomplished by assistance from a custom fabricator?" The answer is, "Without a doubt", provided (1) that the buyer knows exactly what he wants and is willing to pay for the experimental time, and (2) that a custom fabricator can be found who has an experimental department for just such work and is willing to give one customer's problems top priority. We do not know of any custom fabricator who is willing and able to render this type of service or can afford to do very much experimental work without the assurance of ultimate success or of a production order. For this the custom fabricators cannot very well be blamed, but it is precisely this inability or unwillingness which provides one of the most compelling reasons for the manufacturer who has special sintering problems to undertake in-plant production. One of the most successful powder metal departments has been established by a concern which required parts with extremely high strength values and closer tolerances than commercially available. Unable to find such a source among the custom fabricators, they installed a powder metal department with gratifying results.

Cost Advantages

The most obvious advantage of in-plant powder metallurgy is, of course, lower cost of parts. However, in view of the heavy initial investment and the high costs of maintenance, the difference in cost between the parts produced by a custom fabricator and those made by the user himself are a great deal less than would appear on the surface. If the only consideration were the cost of a given part, *per se*, the custom fabricator would in many cases remain in undisputed possession of the field. The less evident but more valuable advantages of in-plant production lie in the saving of time from the



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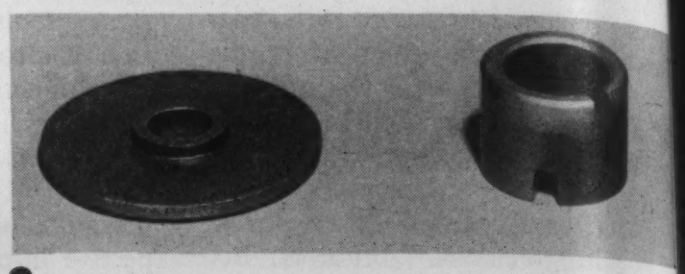

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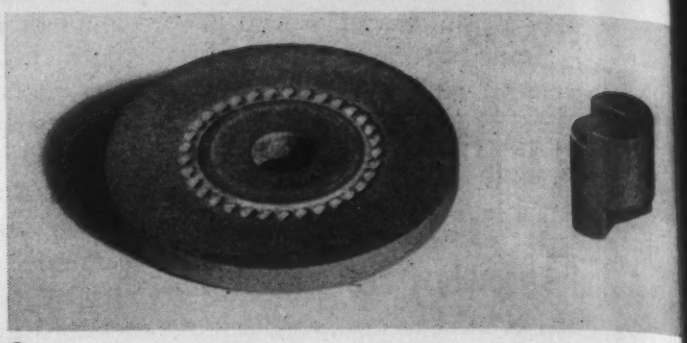

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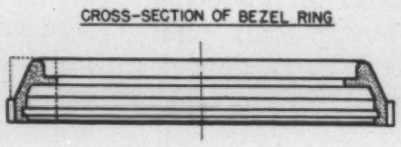


Typical Conversions to Metal Powder Parts at Lionel

Compass bezel ring, illustrated in **1,** is machined from a sintered brass powder blank illustrated on the left. Besides an 80% saving of critical brass bar material originally specified, this conversion eliminated precision machining of 120 serrations required on the periphery of the ring.

Brake disk illustrated in **2,** left, was previously machined from bar bronze stock. Pressing this part from powder not only saved material and machining operations but also utilized the inherent porosity of the sintered part to control the frictional constant of the disk and to provide more uniform torque.

Notched ring shown in **2,** right, was originally designed to be produced from bar stock or tubing. The powder iron counterpart by-passed the perennial bottleneck in screw-machining facilities, eliminated the milling operation required for producing the slots, obviated de-burring operation, and saved a considerable quantity of critical material as well as months of waiting for deliveries. The plating which was added to obtain the corrosion resistance fully met all required salt spray tests.

Illustration **4** shows how three components of a head-set locking assembly which had been made by different processes were advantageously converted to powder metallurgy. Although the sintered grooved pressure plate on the left (bottom) did not result in a great saving over its stamped counterpart (top), it facilitated assembly and improved the function of the part by providing deeper and sharper grooves than can be pressed in sheet metal. The relatively tricky detent ring in the center, which required exactly 72 uniformly spaced radial grooves, was a headache in either screw machining or heading but

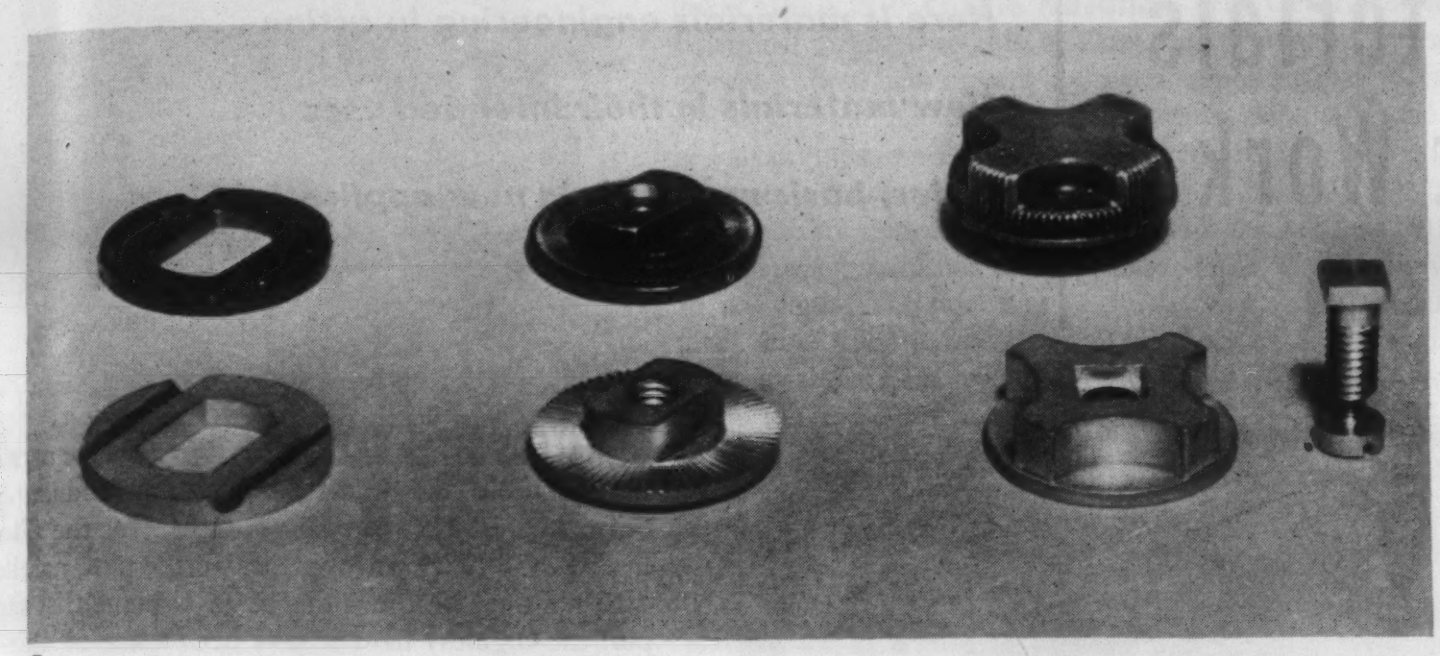
original design to final production and of delivery time on repeat orders, the greater freedom in designing changes, and in the integration of powder metallurgy with other manufacturing processes, such as hardening, carburizing, welding, machining, plating and other surface finishing.

Few, if any, powder metal custom fabricators are set up to perform the many auxiliary operations which may be necessary before the sintered metal part is finally used in its ultimate assembly. And even if they were, in-plant integration of these processes obviously permits closer quality and quantity control. In this respect, as well, Lionel found itself in a particularly advantageous position to fully exploit the possibilities inherent in in-plant production of powder metal parts by integrating this process with a widely diversified assortment of fabricating facilities amassed during the half century of its manufacturing history.

A corollary but important advantage derived from existence of in-plant facilities lies in the educational opportunity they afford to the product designer. No amount of literature or textbook knowledge can replace direct observation of the pressing and sintering techniques with their attendant problems, limitations and peculiarities. Engineers and designers who are exposed to first-hand knowledge of this process will gradually alter existing designs to facilitate the production of parts. As they learn to think in terms of compression ratios, projected areas, die fill and other characteristics of available presses, the designs grow bolder and more ingenious in their application to the end result of reduction of cost and improvement of product.

The Place of the Custom Molder

We have dwelt at considerable length on the advantages of an in-plant powder metal to the manufacturers making such installation, but how about the custom fabricator who has a large investment and is now apparently left holding the bag? How is he affected by the expansion of in-plant production? Perhaps we ought to let the custom fabricators speak for themselves on this point. However, in the opinion of the writer, while the custom fabricator may lose some immediate easy business he



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a "natural" for powder metal. The thumb nut on the right, designed to be turned by personnel wearing heavy gloves, required four milled notches to supplement the inadequate knurling. As redesigned for powder metal, the knurling was eliminated by deepening the notches, while the central projection containing a left- and a right-hand thread was simply inserted in assembly into a pressed square cavity.

In the military specifications the rotor illustrated in **3,** right, could be made by die casting or machining from bar stock. Those who are acquainted with powder metallurgy will immediately recognize that this part is ideally suited for this process from the standpoint of dimensional tolerances, surface, cost and material availability. Needless to say, upon submitting a quantity of temporary-tool-made samples the part was found acceptable.

Lest a false impression is created, it should be said that success does not shine perpetually on the worker in this new field. Many of the parts that are tried fail to meet one or more requirements. The notched plate illustrated on the left of **3** came to our attention when the design was too far gone for a change. At any rate, an experimental tool was built to test the possibility of avoiding the drilling of 33 holes with a wall spacing of but 0.015 in. Experiment proved that the design did not lend itself to successful powder metal conversion, but had the designer been aware of the cost saving through powder metallurgy, he might have increased the radius of the hole circle or staggered the holes in two concentric rings, to cite only two alternate methods of increasing the wall thickness.

will, in the long run, reap some very real benefits as well.

From the writer's observation the great bulk of experimental, development and missionary work has been carried on by in-plant producers. In the automotive field the custom fabricators benefit from the increased popularity of the powder metal process both in the new business they receive from the many manufacturers who have been "sold" on sintered parts and from the overflow of parts from in-plant producers. Today, despite large in-plant operation, Lionel is purchasing millions of sinterings which only a few years ago were made by other processes and which would never have been converted were it not for Lionel's favorable experience with similar sinterings made in its own plant.

In-plant production of sinterings will go on at an ever increasing rate despite the rather absurd attempt at secrecy exercised by some of the old-line diehards in the custom fabricating business. The situation at the present time seems to be parallel to that which existed a few years ago in the die-casting business when the custom die caster jealously guarded his "trade secrets". Already the barriers are being lowered through publication of more detailed useful description of the methods and tools of production. The in-plant producers and some open-minded custom fabricators, mindful of their own struggles to get started, have been exceedingly generous with their "know-how" and allow visitors full access to their facilities and information. One electrical manufacturer, upon visiting the Lionel plant, decided then and there to embark on his own in-plant production. Today, his basic requirements having been satisfied, he is exploring new fields of application which he had never previously considered.

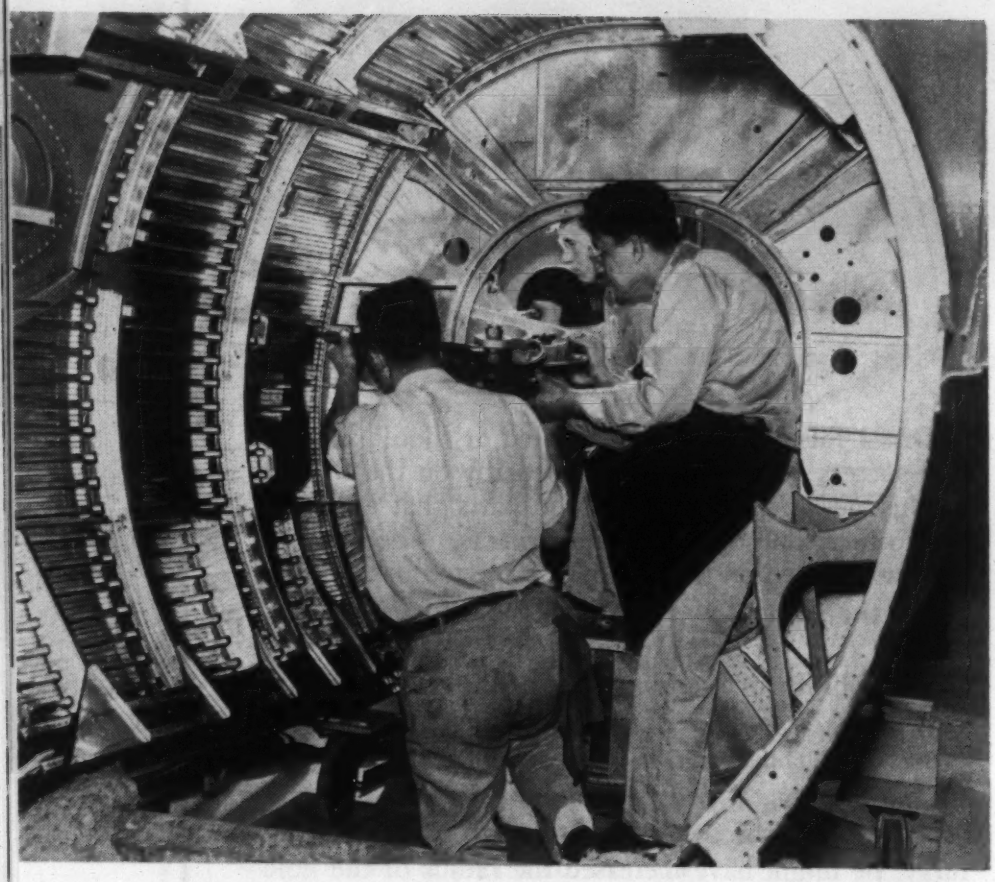
It appears that the specialist need not worry too much about the inroads of the in-plant producer. As in die casting, there is room for both to exist side by side, each covering a definite need in the field. Such development is a natural process in our industrial life and redounds to the eventual benefit of all concerned through lower costs to the manufacturers and better quality at lower prices to the ultimate consumer.

Materials at Work

Here is materials engineering in action . . .

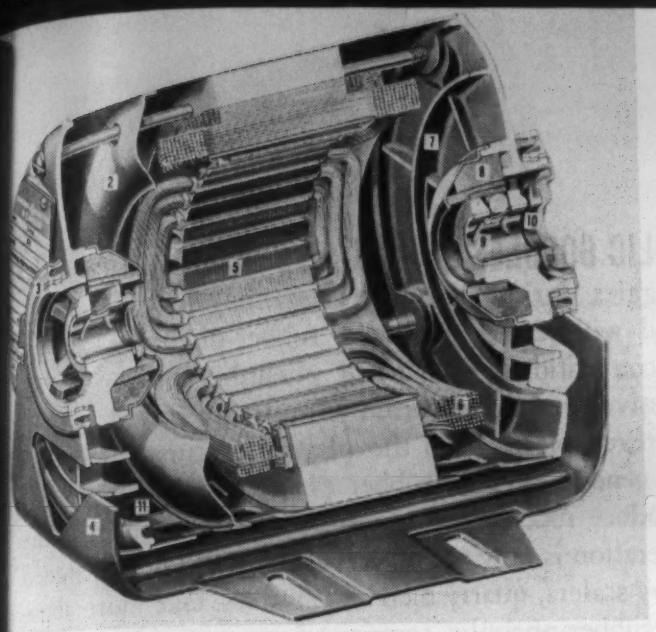
New materials in their intended uses . . .

Older, basic materials in new applications . . .

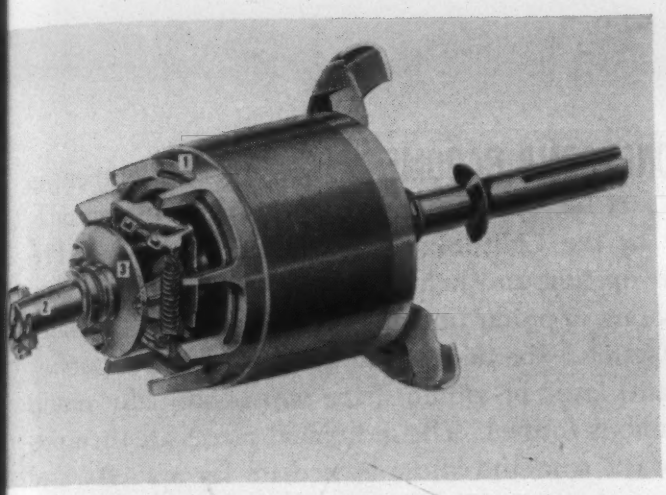


STAINLESS STEEL NACELLE An airplane nacelle made entirely of stainless steel is being produced by Solar Aircraft Co., San Diego, Calif., for the Lockheed P2V-5 Navy patrol plane. In the past, nacelles (the housings on the wings of an airplane that support the engines) have usually been made of aluminum. Stainless steel has been employed in this new Lockheed design to obtain greater structural strength with less weight. Making nacelles of stainless steel was a very difficult engineering and production problem. To gain maximum strength, an extremely hard form of stainless steel was used, leading to an unusual number of problems in forming the metal to precise specifications. The nacelle assemblies contain 470 detail parts, which require the use of a great many special tools, jigs and facilities. Each nacelle weighs 175 lb, and on the finished P2V-5 will support an engine weighing 3500 lbs. The nacelles are 6 ft high, 5 ft wide and 6 ft long.

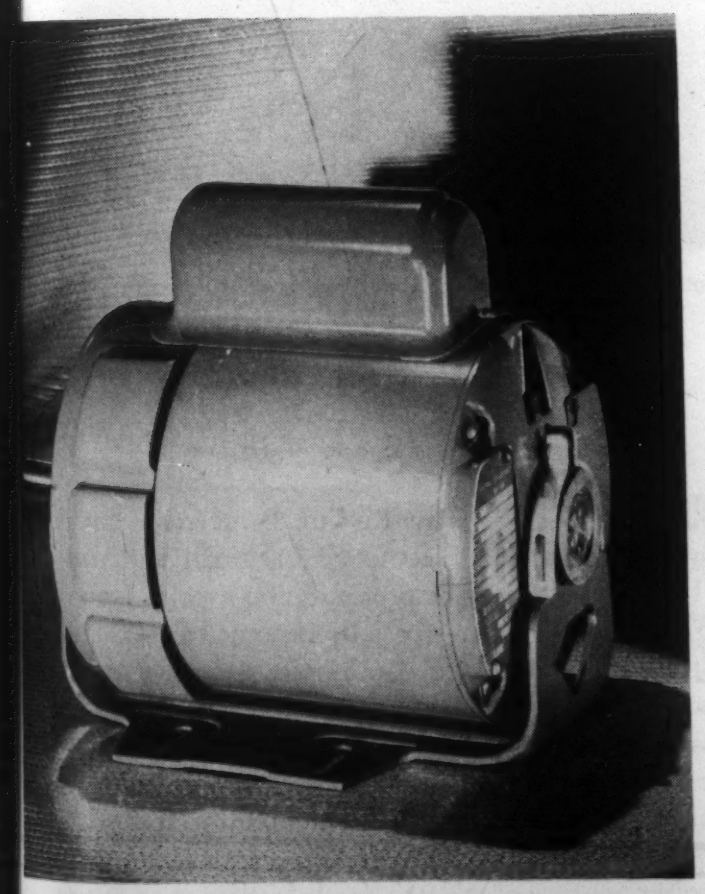
PLASTIC AIR FILTER A washable plastic air filter for forced draft hot air furnaces and air conditioning systems is capable of catching pollen from the air and even the most minute solids in cigarette smoke. The new filter, developed by The Goodyear Tire & Rubber Co., is a self-charging electrostatic unit. It uses a thin polyethylene film, shredded into a porous mass. When this mass is exposed in a current of air it picks up on electrostatic charge. The charge attracts and retains the finest dust, soot or smoke particles in the air. Laboratory tests show the new filter to be 2 to 4 times as efficient as oil-coated and other types of filters which collect particles on their surfaces by impingement. The Goodyear filter, by the nature of its dielectric properties, is effective through its entire thickness. It can be cleaned by rinsing in cold water. No detergent is required.

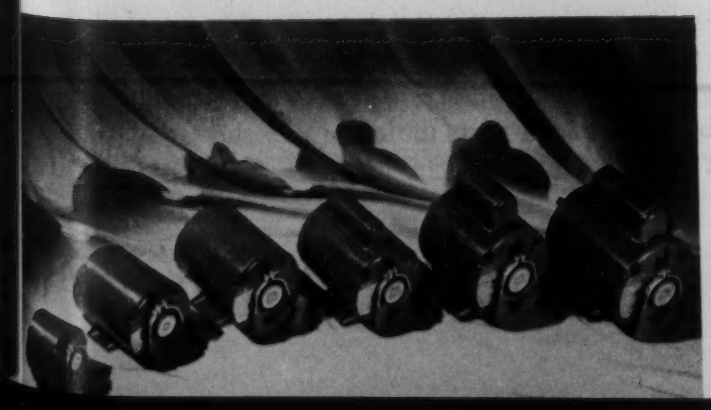


Steel shell. 2. Baffle ring. 3. Resilient ring. 4. Steel cradle base. 5. Stator core. 6. Insulation system. 7. End shields. Felt wickings. 9. Sleeve bearings. 10. Oil thrower. 11. Ventilating openings.



Aluminum rotor winding. 2. Locking device. 3. Centrifugal mechanism.





MATERIALS IN ELECTRIC MOTORS

The General Electric Co.'s Fractional Horsepower Motor Dept. has announced a new line of motors. These new motors are the result of years of development and incorporate many new design features. Weights have been cut in half on most models, the versatility has been broadened, and the appearance modernized.

The electrical industry long has depended on such insulating materials as paper, varnished cambric, cotton tapes, pitches and varnishes. In developing the new motors, however, a radical departure was made from this tradition. No cellulose or other natural insulating materials have been used. For sheet-type insulation—that is, slot liners and phase insulation—nylon was used. It is probably the first time in history that this tough, heat-stabilized, and extremely moisture resistant material has been used in standard, production-line electrical equipment. Combined with Formex insulated wire and Glyptal varnish, nylon provides an insulation which—if the results of accelerated life tests are any indication—will be as good after 50 years of use as it is when brand new.

Although no increase in recommended maximum temperature is being advocated, the new insulating system will significantly improve the factor of safety in so far as abnormal conditions and accidental overloads are concerned.

While this new insulation has proved itself under extensive examination, G-E engineers are already working on a still newer insulating material, which preliminary tests indicate may be even better than nylon for motor purposes—a material with still better heat-aging life, greater physical strength, plus all of nylon's other advantages. It is Mylar, or Polymer V, or V-film, a cousin of nylon having the same familiar long-chain molecular structure. It will replace nylon when it is available in sufficient quantities, perhaps within a year or two.

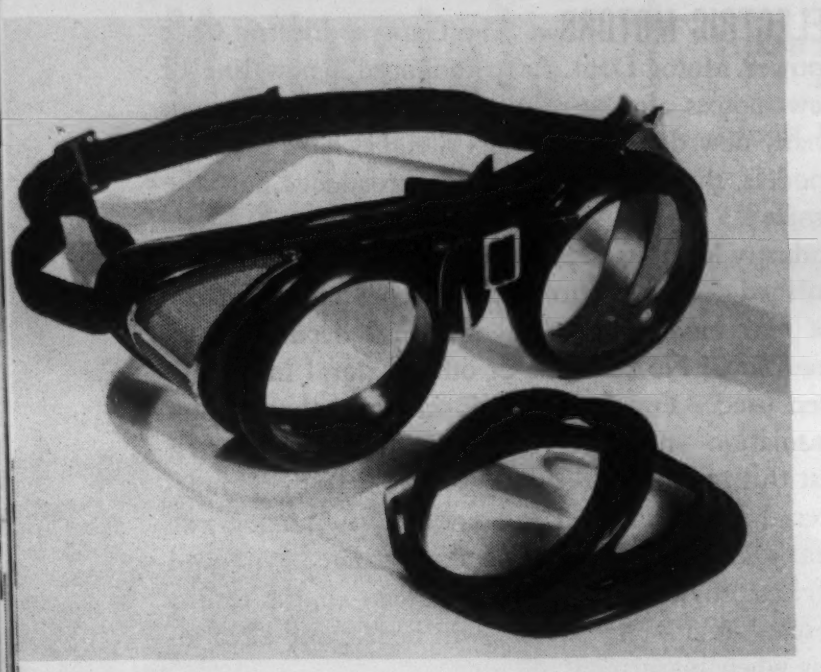
Other components of the new motor have also been designed with the three basic objectives—size and weight, useability and appearance—in mind. The steel stator shell is lightweight, strong, precision machined; assures permanent true alignment. Its surface is phosphatized for corrosion protection. Flat, disk-type end shields of die-cast aluminum, especially ribbed and reinforced for extra strength, provide the rigidity necessary to withstand the stresses of heavy radial and end-thrust loads.

The stator core, of welded construction, is finished to close tolerances, but is kept slightly larger than the inside diameter of the stator shell. In assembly, therefore, the shell is expanded slightly, within its elastic limits, to receive the core. The result is a sturdy assembly that has been proved immovable by repeated drop and shock tests.

The aluminum rotor winding is made by a vacuum-pressure casting process new to the motor industry. The process produces a denser winding, resulting in more uniform performance. Large ventilating fins, cast integrally with the winding, provide the maximum amount of air flow within a relatively small space.

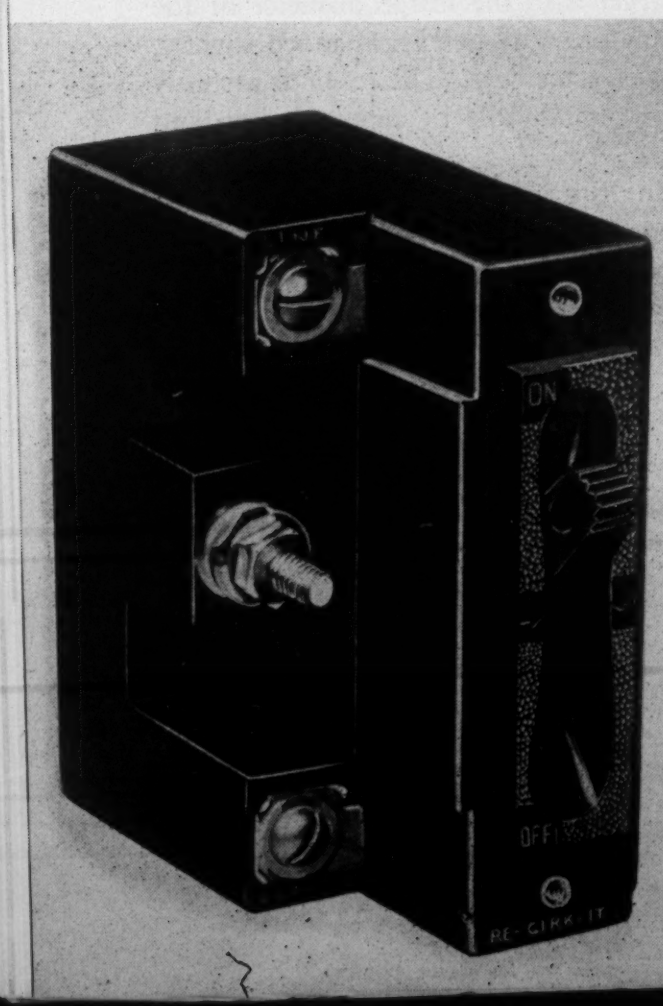
The blue-gray finish of the new motor is a chip-free, baked melamine enamel which is highly resistant to marring or scratching, oil, high humidity, and heat and cold shock. It has good qualities of adhesion and flexibility, harmonizes with most machines, and also provides a good paint base, should the ultimate user choose to finish it to match his equipment.

Materials at Work



RUBBER-PHENOLIC GOGGLES High scrap losses on Bausch and Lomb safety goggles during assembly operations have been substantially reduced with General Electric rubber-phenolic molding powder. With conventional flock-filled phenolic compound formerly used, excessive breakage occurred when the metal side screens were riveted in three places onto the plastics eyecups. With the adoption of the general-purpose rubber phenolic, the same molds were used to produce much stronger parts. Breakage during the rapid riveting operation is now negligible, and the goggles, designed for rough usage by scalers, quarry men and riveters, take more abuse in service. The rubber-phenolic compound owes its high impact resistance and resilience to its nitrile rubber component. The Auburn Button Works, Auburn, N. Y., is the molder.

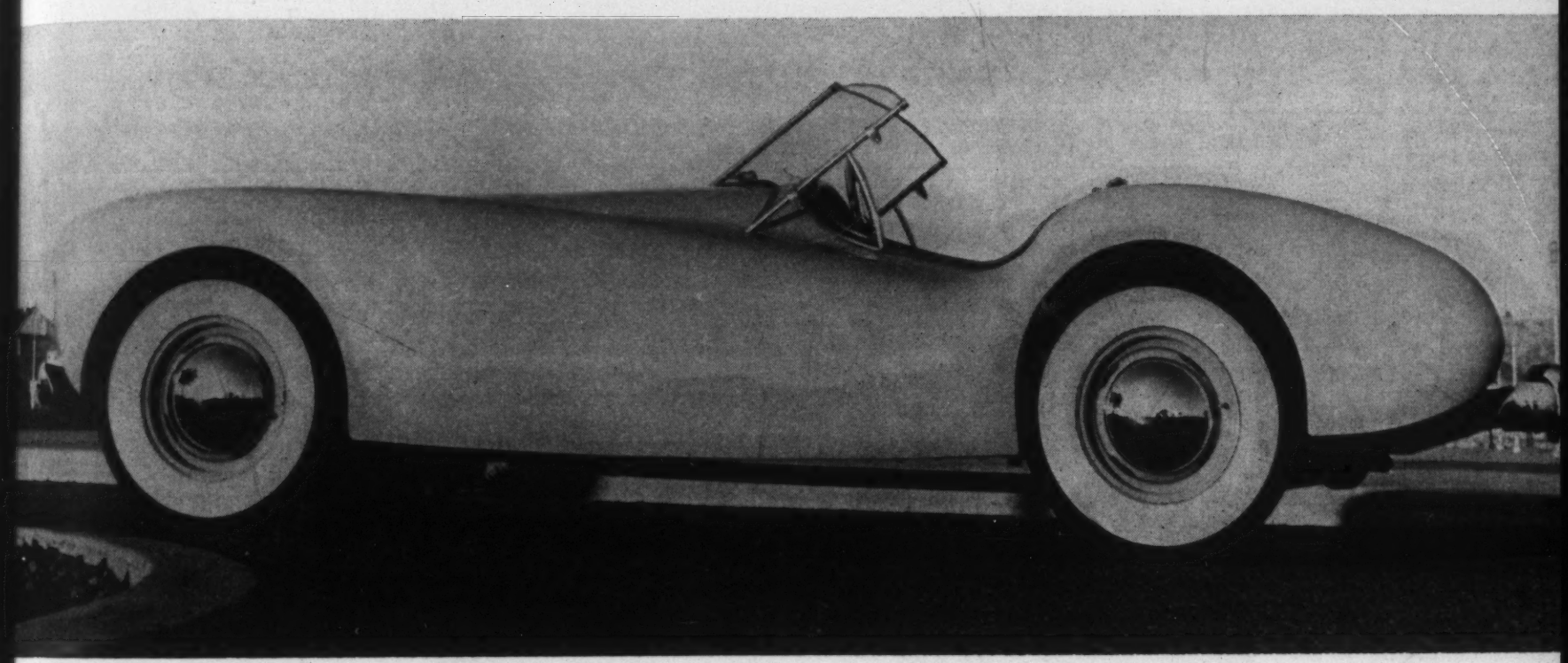
PRE-SHAPED HONEYCOMB RADOME A recent development in reinforced plastics is the pre-shaping of glass fabric honeycomb, now being done by the California Reinforced Plastic Co. Pre-shaping speeds lay-up time and helps eliminate need for additional floor space and tooling in production of such components as radomes for aircraft construction. The first step in the process is pre-curving to eliminate the anticlastic or saddle shape which normally results when flat honeycomb is formed. The individual pieces are then pre-cut to eliminate waste trim and allow immediate lay-up. As used in North American Aviation Co. F86D, 13 identical pieces and one nose piece are furnished for each radome. Pieces are laid up and laminated with a minimum of time expended.



PHENOLIC CIRCUIT BREAKER This Re-Cirk-It magnetic circuit breaker, made by the Heinemann Electric Co., is small and inexpensive, and can be built-in to provide protection on overload, short circuit or locking. Features of this specially designed breaker include long-time service with no maintenance, minimum and instantaneous trip points unaffected by ambient temperatures, and cadmium-plated parts to prevent corrosion. The breaker may be reclosed at once after it has tripped, provided the current has returned to normal. The hermetically sealed trip unit opens on a continuous overload, but allows the passage of the high current needed to start the engine. The entire housing of the Re-Cirk-It is molded of Durez phenolic, a material particularly well suited to this type of application because it is self-insulating, has high dielectric strength, is unaffected by quick temperature changes, and is easily molded with inserts for assembling the metal parts molded in, in the same operation. Molding is done by Kuhn & Jacob Molding and Tool Co.

—A *"TRENDS IN MATERIALS"* Feature

Future of Reinforced Plastics Indicated by Use in Auto Body

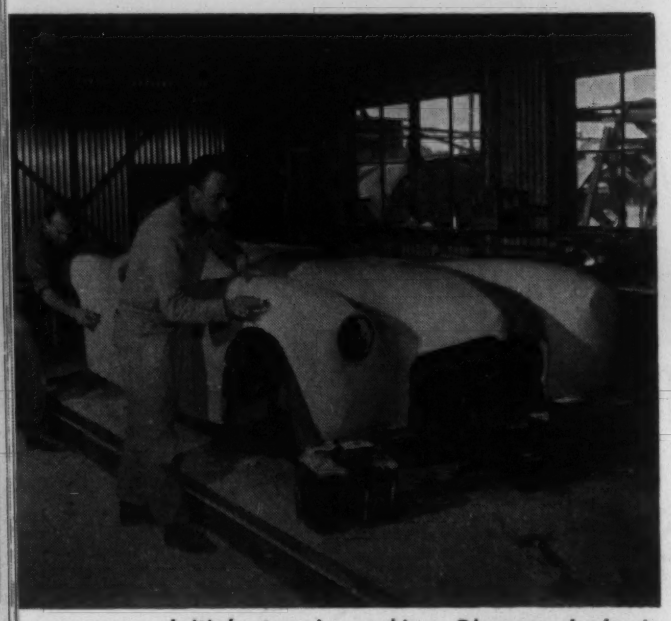


Reinforced plastic car produced by Naugatuck Chemical Div., United States Rubber Co. and Glasspar Co.

Reinforced plastic car produced by American Cyanamid Co. and The Wilro Co.

● AMONG THE MOST interesting exhibits at the recent Plastic Exposition in Philadelphia were two reinforced plastic automobile bodies. Both were custom-built sports car designs. One was molded by the Glasspar Co. from resins supplied by the Naugatuck Chemical Div. of United States Rubber Co. The other was made by the Wilro Co. with American Cyanamid Co. resins.

Neither of these plastic automobile bodies is scheduled for mass production—at least not for mass production on the Detroit scale. Just the fact that plastics people are thinking in terms of traditional steel applications like car bodies is important, however. As a matter of fact, the



Initial step in making Glasspar body is to make a wood and plaster male mock-up. A female production mold of glass-reinforced polyester is made on the mock-up. (Production sequence courtesy United States Rubber Co.)

To make the female production mold, a polyvinyl acetate parting agent is first put on the mock-up. This is then covered with a hot coat of polyester.

Polyester and 5 layers of glass mat and cloth are used to build by the production mold. The preliminary hot coat of polyester assures a smooth surface finish.

sporty one-piece bodies may be more prophetic for refrigerator, washing machine and home equipment designers than for the motors people.

Car Bodies

The rust-proof bodies are constructed of polyester and layers of glass fibers, a combination which is hailed as stronger for its weight than steel. Because of its resiliency, the polyester-glass combination springs back to its original shape after impact. Breaks are possible under heavy blows, but the damage can be repaired easily and cheaply. The plastic surface also holds paint well.

Both bodies now sell for less than $700, while a custom-built metal body costs $3000 to $5000. They are sold to be mounted on separately purchased chassis. The Glasspar body is molded in one piece, weighs 185 lb and is 0.2 in. thick. Two layers of glass fiber mat and two layers of glass cloth are used. The body is about 65% polyester and 35% glass. The Wilro body is molded in four parts and is attached to the chassis by eight bolts.

These costs and performance data are not the whole story, however. No one claims that steel will be seriously challenged as an auto body material. On mass production models, where the heavy machinery and expensive molds necessary to form the metal can be spread over a large number of bodies, steel is still king. A custom-built body is another story, though. Here the molds and equipment used with reinforced plastic represent only a small fraction of the investment for metal-fabricating dies and machinery. For a custom-built body the material costs (plastic-vs-steel) are a negligible factor.

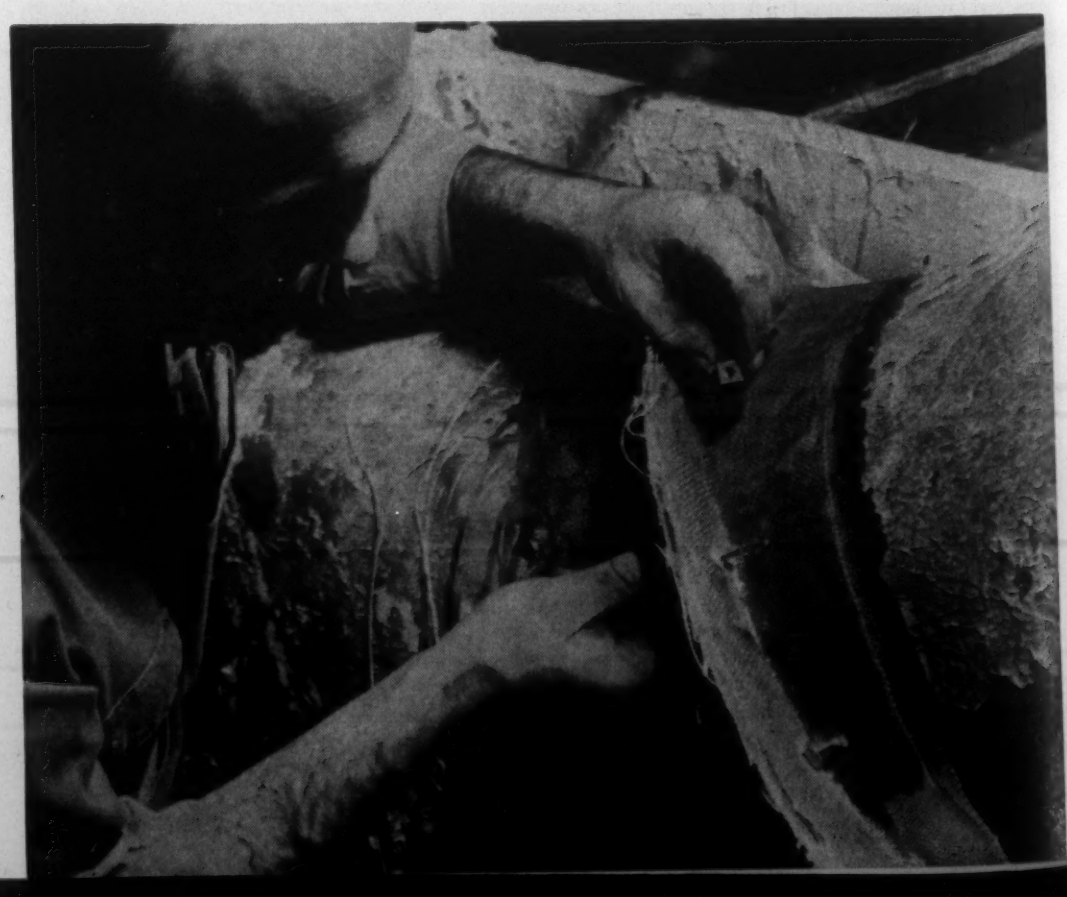
New Applications

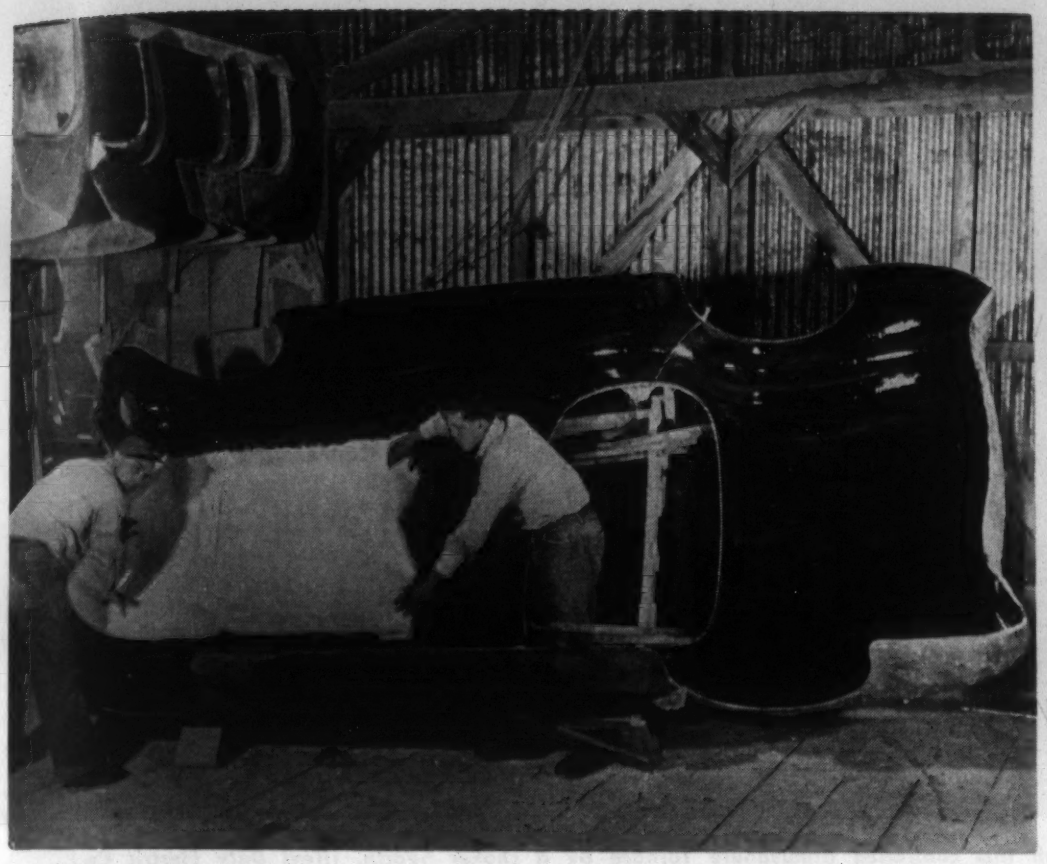
The new automobile bodies are important in the possibilities they point out for other products. With an eye to improving product quality and/or reducing costs, many manufacturers and many different industries are turning to reinforced plastics.

In home appliance construction, for example, the trend is strong toward the material. Refrigerator manufacturers are actively interested in its properties. Some are already using it for gussets and strike plates connecting inner and outer compartments, where the material's low thermal conductivity cuts down heat entry, and for corrosion and rust resistant drip pans. A number of washing machine manufacturers are now using or preparing to incorporate reinforced plastics into their lines. One such firm, which had designed a spiral-bladed agitator to increase churning efficiency 30%, discovered that the cost of producing and assembling the required 22 metal parts was prohibitive.

Now the concern makes the same design agitator—equally strong, much lighter, more corrosion resistant—with only two reinforced plastic parts, for considerably less money. Housewife prospects for vacuum cleaners now are offered a lighter, more manageable tank-type cleaner, thanks to the weight reduction afforded by replacement of metal in the dust bowl and other parts with

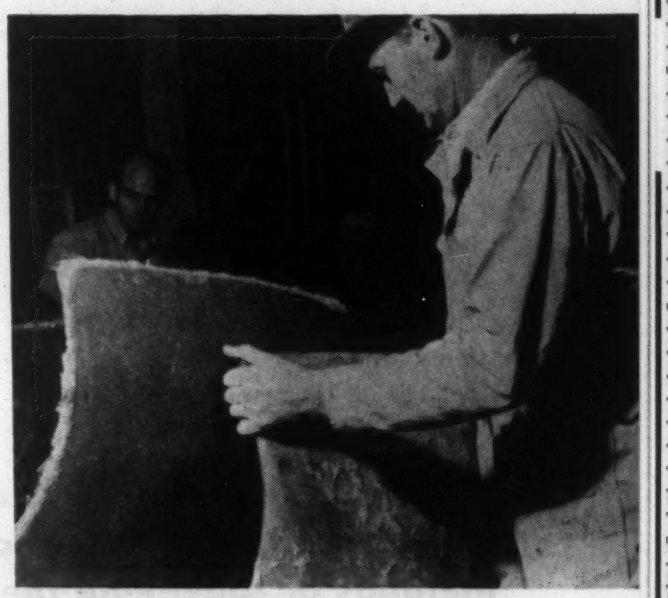
The female mold is cut apart near the driver's seat. Flanges of glass cloth and resin are then attached to the mold and the parts are bolted together again.





The inside of the production mold is coated with the parting agent, an initial coat of polyester is applied, and the glass mat is laid up for the actual body.

Glass cloth is then laid over the glass mat and coated with polyester resin. The actual body is being made here.



The plastic is squeezed to eliminate air bubbles and assure a uniform dispersion. The process is then repeated to obtain the final thickness.

All corners and edges of the body are trimmed with portable light sanders. Splash pans are added and the body is painted.

reinforced plastic.

Reinforced plastics are also figuring prominently in many other products—in dent-resistant tanks for chemicals and acids; protective safety helmets for industrial workers; electrical insulation laminates; sturdy, precision-molded housings and other parts for motors and machinery; in skis, fishing tackle boxes, chairs and even coffins.

The armed services are claiming substantial amounts of reinforced plastics for more than 125 separate end uses. Air Force needs are particularly great for the high-strength low-weight material in ducting, bulkheads, radomes, self-sealing tanks, in strument housings and many other parts. The Navy and Coast Guard are actively interested in reinforced plastics for small boats, pontoons, pipe for carrying salt water, and many other items. Reinforced plastics are also going into rockets, Arctic cargo sleds, many types of cases and containers. A dramatic use, attempted late in World War II and revived for forces in Korea, is reinforced plastic body armor so tough it repels flak and other missiles.

The Future

One thing seems to be characteristic of all the markets being explored by glass-reinforced polyester. This material can replace metals—even steel—on large area applications. In every case, however, the cost of the plastic will be greater than that of the metal. To make the plastic competitive or preferred, some other factor must be present. Since the price of glass and polyesters are not likely to drop too much in relation to metals in the next few years, this rule should continue to apply. Reinforced plastic is a good bet—if its easy forming, good corrosion resistance, or good electrical properties outweigh the initial material price differential.

There are still some problems to be ironed out. Production methods for the new auto bodies are still being developed, for instance. The first models took a lot of time and labor. The manufacturers hope that matched metal molds and die-cut pre-forms will cut production time to somewhere near 5 min. The glass-reinforced polyesters must still be given a covering finish, unless the white glass filaments on the surface are acceptable. To fasten sections together, thicker sections are required around the bolts.

In any case, these reinforced plastics have an interesting future. They are engineering material in their own right, and should not be considered merely as substitutes for metals. They will be used increasingly, as more is learned about their design and fabrication in products.

—Philip O'Keefe, Jr.

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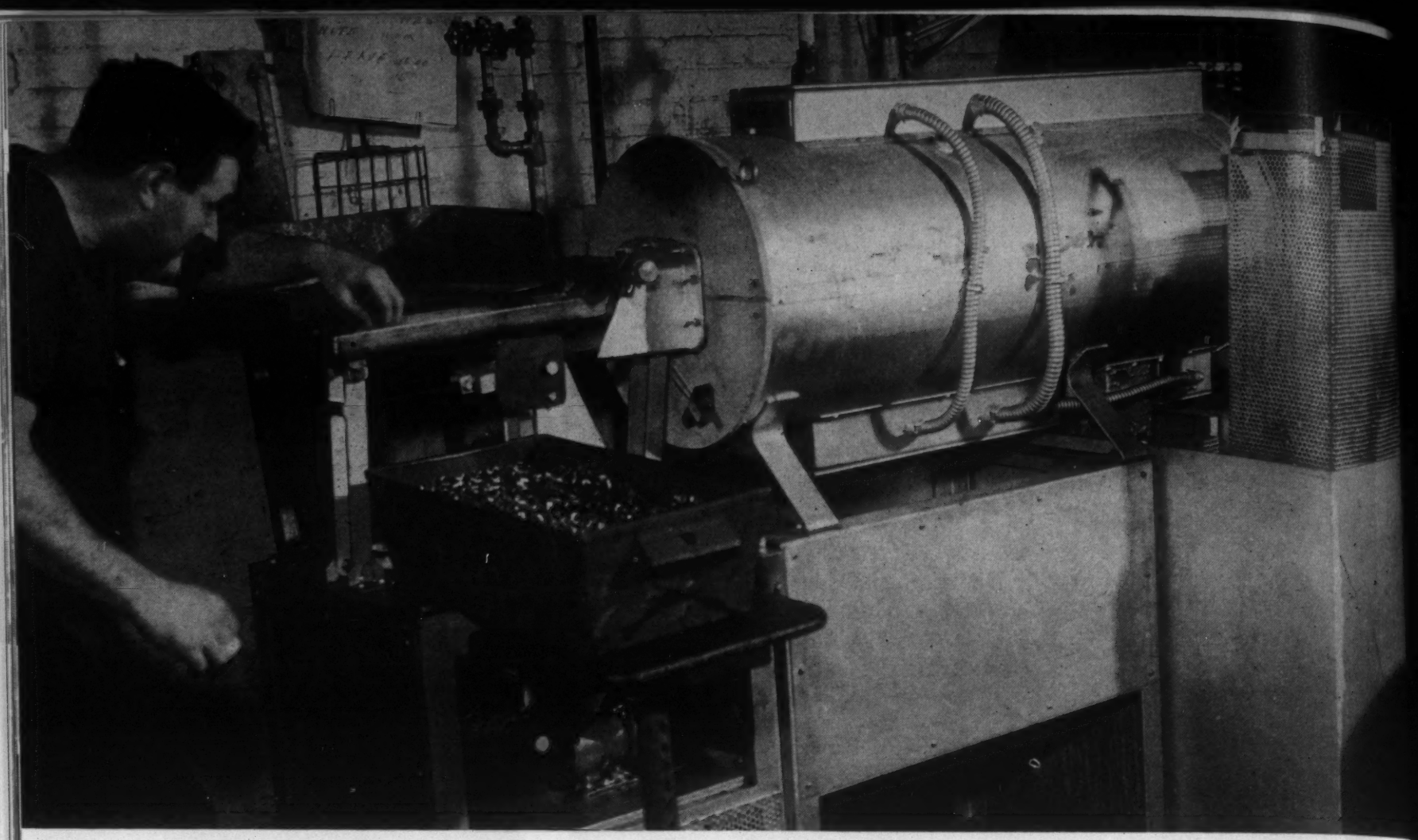


Alloy steel springs are moved through this controlled atmosphere furnace by a choker hearth. (Hevi Duty Electric Co.)

How to Harden Small Steel Parts

Here are some useful tips on ways to avoid precooling, preventing decarburization, and methods of conveying the work through the furnace.

by KENNETH ROSE, Western Editor, Materials & Methods

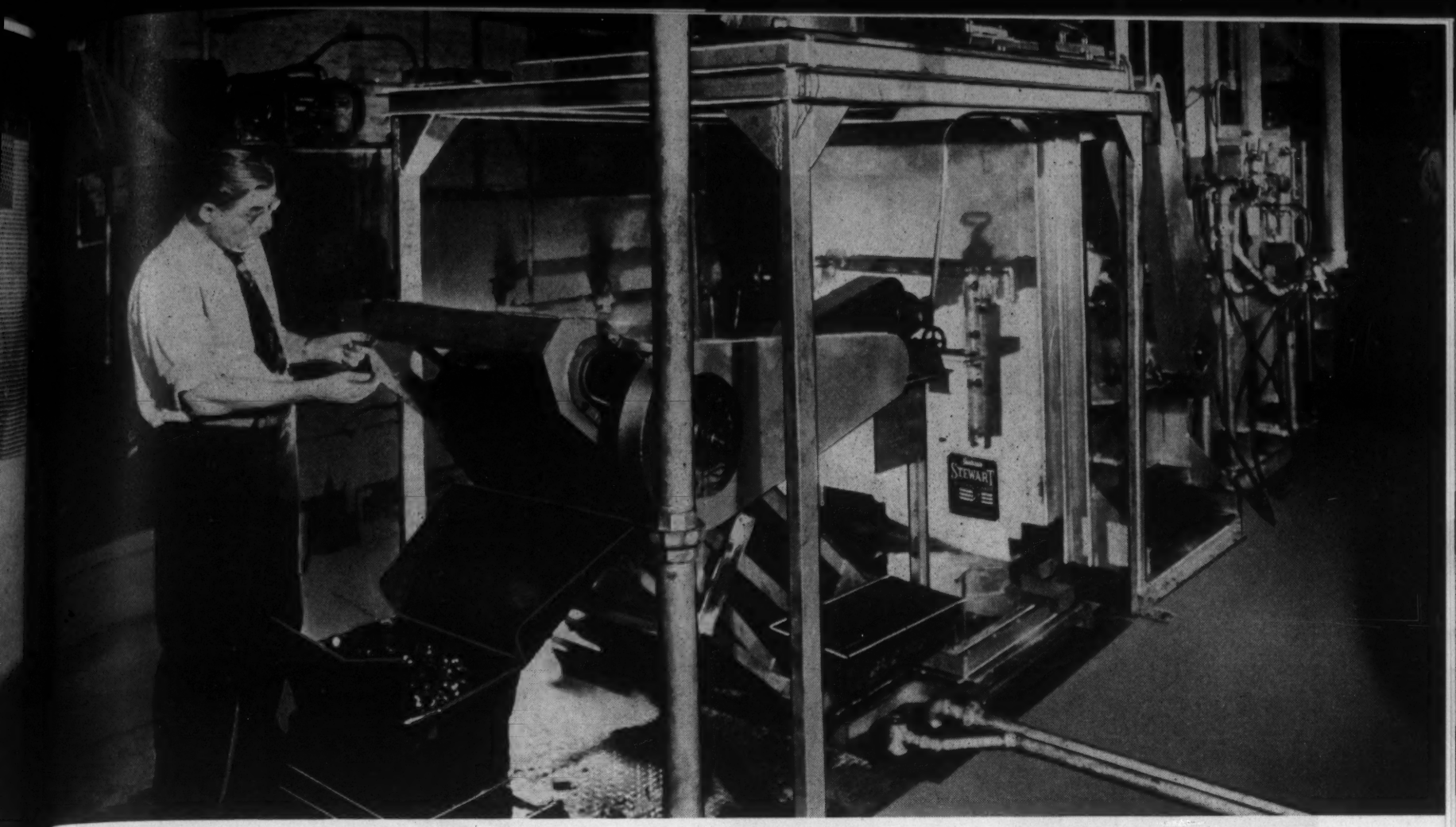
● Most pieces of manufactured equipment contain, in addition to the principal structural units, some small pieces used as fasteners, spacers, miniature actuation units, and the like. In addition, there are articles that are in themselves small, such as fish hooks. Pieces such as these are frequently made of steel, and require heat treatment to develop maximum mechanical properties. They present special problems to the heat treater that are solved by some interesting devices and procedures.

The hardening of such small parts as lock washers, lock nuts, small coil springs, clips, hooks, small bolts and special machine screws is usually large-quantity work. The steels used respond readily to heat treatment; they are frequently plain-carbon steels, and the result desired is generally not above a spring temper in hardness. A common problem in heat treating, that of securing proper heat distribution in pieces with considerable change in thickness, is not ordinarily a difficulty in the heat treating of small parts. However, there are other problems chiefly due to the fact that small parts are heat treated in mass rather than as individual pieces. The three most important ones are described below.

Avoiding Precooling

The quantity of heat held by a small part, such as a coil spring, is so small, and its ratio of area to volume is so large, that it can cool several hundred degrees in a fraction of a second if exposed to air room temperature. However, if this precooling is slower, the quenched piece has martensite with some pearlite, bainite, etc., as its metallographic constituents, and is softer than a piece that is essentially martensitic in structure. It is one of the major problems in the heat treating of small pieces to avoid the knee of the isothermal transformation curve, or S-curve.

The matter of avoiding air cooling while the work is passing from the furnace chamber to the quench is usually handled by the furnace designer. It sometimes happens, however, that a furnace must be used for a type of work for which it was not intended, and it then becomes the problem of the engineer to make such modifications in the furnace or in the heat treat accessories as will give satisfactory results. Some of the methods of avoiding loss of heat from the



Springs of a variety of sizes and shapes are heat treated in this furnace without decarburization. (Sunbeam Stewart Industrial Furnace Div., Sunbeam Corp.)

work during travel from furnace chamber into quench are:

1. *Quick dumping.* By dropping the basket containing the work, or by emptying the basket by tilting, directly from the furnace chamber into the quench, the transfer can be accomplished in a fraction of a second. In some installations the pans are attached to an endless conveyor belt, and are tilted and dumped as the conveyor reaches the discharge end of the furnace and moves around the roll for the return trip. This kind of dumping tends to cause tangling of work. Even when a gravity dumping is not used, work can be quickly lowered from an overhead conveyor operating inside the furnace, with the work in baskets or on fixtures.

2. *Use of thick-bottomed trays or baskets.* Precooling of very small parts can sometimes be prevented by using containers that will act as reservoirs of heat. A disadvantage is that there is an increased loss of heat from the furnace.

3. *Enclosing the furnace discharge end.* At the time of building the furnace, this might involve designing for total enclosure of both chamber and quench. Even after the furnace has been built, it is usually possible to construct a hood or vestibule over the discharge end that will shield the work as it is quenched.

Conveying the Work

Moving a great number of very small pieces into and through a heating chamber, quenching medium, and occasionally a draw furnace requires a means of conveying that will avoid the loss of any substantial quantity of parts, will avoid excessive tangling where the shape of the piece is conducive to tangling, and will avoid blanketing where carbon restoration or other special atmosphere is a part of the process.

Conveying of the work is primarily a matter of furnace design. While there are many types of furnaces and conveying mechanisms, and their detailed study is not a part of a discussion of the heat treating of small parts, the means of conveying can be grouped as those in which the work is moved in or on holding devices and those in which it is moved without such devices. In the first group are (a) boxes, baskets or trays in which the work is carried through such furnaces as the batch furnaces, pit or oven type, or on rollers, belts or overhead conveyors through several types of continuous furnaces, or is pushed through pusher type furnaces; (b) rods, hooks, "Christmas tree" fixtures or other hanging fixtures attached to overhead conveyors, and moved through salt bath furnaces and many oven type furnaces.

In the second group the work moves through the furnace without the help of a container or overhead fixture, and these conveying methods include (a) gravity conveyors, in which the work slowly slides through an inclined and rotating furnace, which may be a continuous rotary or a bath-type retort; (b) belt conveyors, in which the pieces are carried through the furnace on a slowly moving belt; (c) shaker types, in which the pieces are slowly jolted through furnaces by a repeated longitudinal shaking of the hearth, or of the furnace; and (d) screw conveyors, in which a slowly revolving screw pushes the work.

The shape of the workpiece is one of the factors in choosing the type of furnace or conveying system to be used. Pieces having the form of a hollow cylinder, or perforated disk, or well-curved hook, such as spring washers, coiled springs or tubular pieces, can sometimes be threaded onto rods or hooks for conveying, where this extra handling is justified. Pieces that are especially susceptible to tangling, such as hooks and some types of springs, will be less subject to interlocking in shaker-type furnaces than in rotary furnaces; they can be carried in divided boxes or trays also.

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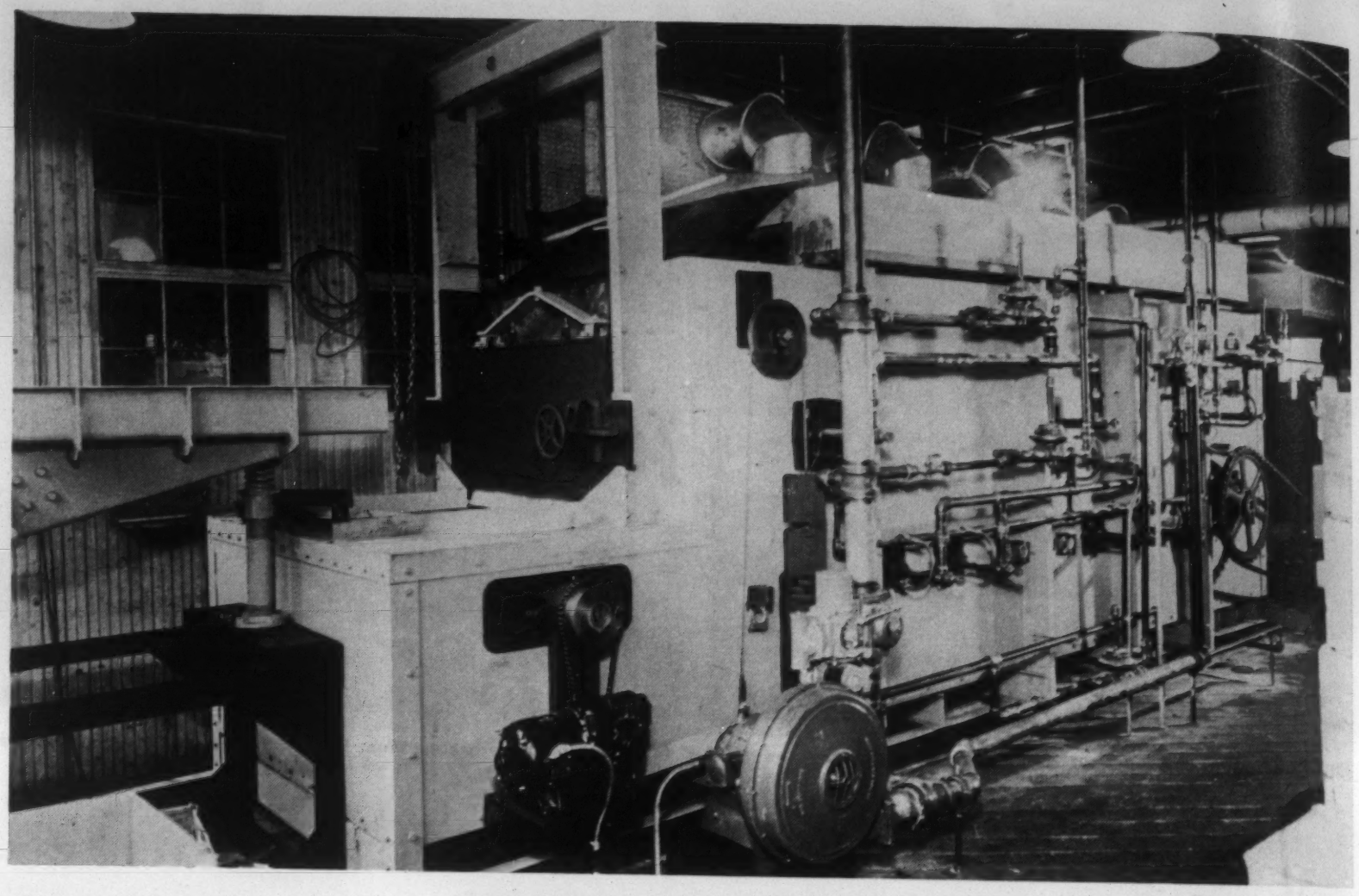

Spring clips for machine gun cartridges are hardened to close tolerances, in large quantities, with this heat treating set-up. (The Electric Furnace Co.)

Novel type step conveyor facilitates the clean hardening of small bolts. (Holcroft and Co.)

For such pieces as bolts the chain belt conveyor seems to be preferred. It is not recommended for very small parts because of the danger of pieces falling between the links. The roller hearth and the mesh belt are widely used in connection with conveying in boxes, baskets and trays. They permit use of lighter weight containers than do pusher type furnaces, and so reduce heat loss by reducing the tare weight to be heated.

The rotary furnace eliminates the danger of blanketing of one piece by another, and so tends to bring all the pieces up to temperature at the same time. It is especially useful when atmosphere control must be maintained. The rotary retort is a batch furnace that affords atmosphere control.

Feeding the furnace can be done by a hopper and chute if the pieces are moving through the furnace without containers or fixtures. Hand loading from a loading platform is common practice. Work subject to tangling is sometimes vibrated by an electric or electronic vibrator to produce a thin layer of pieces over the conveyor belt. When the work is moving through the furnace in containers or on fixtures, the problem of tangling is minimized. Fixtures are loaded by hand, and containers can be placed on a belt conveyor or carried on an overhead conveyor. The pusher-type furnace provides semi-automatic loading combined with the transporting method.

Decarburization

While some loss of carbon from the surface of the steel is not a serious matter with much of the small work being heat treated, and no atmosphere control is exercised in the furnace, other parts would be made unfit for service by decarburization and the resulting "soft skin." For example, bolts, with threads formed by

rolling and heat treated to improve strength, dare not be decarburized.

Decarburization is a problem that might begin with the heat treatment of the steel for the part in question, or could have arisen during an earlier hot-forming operation, or may have its origin at the mill during the processing to rod, bar or other standard form. Its seriousness depends entirely upon the requirements for the part being heat treated. For many pieces, the slight decarburization occurring during heating to hardening temperature is of no consequence, and no attempt is made at atmosphere control in the furnace. In other cases the work must be not only protected during heat treating, but carbon lost during mill processing must be restored.

Cold rolled stock as it comes from the mill usually has a decarburized surface from 0.001 to 0.0015 in. deep. Hot rolled bolt rods have a surface decarburized zone from 0.005 to 0.0075 in. in thickness. In bolts made by a cold heading operation, followed by thread rolling, most of the total depth of the thread will consist of decarburized steel and be incapable of responding to the subsequent hardening. Such bolts cannot meet aircraft standards, and carbon restoration during heat treatment is necessary. When service requirements are not so severe, it is sometimes sufficient to remove scale, which will, of course, be decarburized, by tumbling or other low-cost means.

Typical Installations

At the plant of American Spring and Wire Specialty Co., Chicago, lightweight wire springs are heat treated to develop high load and fatigue strength. Decarburization must be avoided, and removal of decarburized metal is not satisfactory because of the high cost of blast cleaning and the reduction of cross-sectional area that would result. The springs are heat treated in a gas-fired continuous furnace, with a woven wire belt conveyor, and close atmosphere control maintained. An atmosphere slightly on the reducing side is developed by a cracking unit that uses city gas.

Wire spring as small as 0.016 oz in weight must be hardened to 42 to 45 Rockwell C. The pieces are fed onto a charging platform, taken inside the furnace, and picked up by the conveyor belt, which is equipped with 2-in. guard edges. The belt is completely enclosed in the muffle. In the first zone the work is brought up to temperature, and the second zone provides for soaking so as to insure uniformity of results. At the discharge end of the furnace the work slides down an alloy chute into the quench oil. As the chute is entirely enclosed within the furnace, the protective atmosphere functions until the work reaches the oil. The chute is water-jacketed to prevent excessive flash-back of the oil. The work comes from the hardening treatment without scale, and requires only a degreasing to complete the process.

At the Reliance Div. of Eaton Manufacturing Co., one of the important small items is lock washers. These split washers are hardened to 60 Rockwell C, then drawn back to 49 to 52 Rockwell C to produce a piece with a hard spring temper and exceptional toughness. The material used is 1060 steel for all sizes.

As the lock washers are nontangling there is no need for special handling of the work processing. Hardening is done in shaker hearth furnaces. The washers are fed from a hopper onto the loading apron and carried through the furnace by the motion of the hearth. No attempt is made at atmosphere control. Furnace temperatures are 1500 to 1550 F. At the discharge end the work falls into the quenching oil, which is held at about 100 F. The pieces are tumbled in sawdust to remove any oil remaining after draining, and then are tumbled again in fresh sawdust to remove scale. This procedure removes most of the decarburized surface also. The washers are then drawn back to 49 to 52 Rockwell C by heating to about 620 F in a drawpot.

A completely mechanized heat treatment for bolts gives high production with a maximum of handling in the plant of a Middle West manufacturer. The ½-in. bolts are loaded into the furnace on a step-up type loader which discharges into the furnace chamber, where a reducing and slightly carburizing atmosphere is maintained by an endothermic generator. The work is carried through the furnace on an alloy belt. Furnace temperature is maintained at 1575 F. After about 35 min. in the furnace the pieces are quenched by being discharged from the belt conveyor through the furnace floor into an oil bath at 120 F. A quench chute guides the work and protects the oil from furnace temperature. The hardened stock has an average hardness of 45 Rockwell C.

To complete the heat treatment, a bucket conveyor removes the pieces from the oil bath and transfers them to another conveyor. The second conveyor carries them through a spray washer to remove all oil, then through a draw furnace held at 1090 F, where the hardness is drawn back to an average of 22 Rockwell C. The work is in the draw furnace for 35 min. After the conveyor leaves the discharge end of the draw furnace, the work is carried through a tank filled with a rust preventive solution, and then is taken by a belt conveyor to hoppers from which it is discharged directly into shipping containers.

Raymond Manufacturing Co. hardens small springs of vanadium, plain carbon and stainless steel, and small steel stampings, at its Corry, Pa., plant. A controlled atmosphere is used for all hardening, the composition of the atmosphere being changed to give best protection to the type of steel being hardened. Cracked ammonia is used as the basis for the atmospheres. For plain-carbon steels and alloy steels other than stainless, a small amount of a carburizing gas, propane or natural gas is added to insure against decarburization. The gas is piped into the furnace chamber through the quench chute.

Because of the variety of work processed at this plant, the furnace is equipped to use either hopper feeding or manual loading. The furnace is of the shaker hearth type, and the work is moved through the furnace chamber by the motion of the hearth. At the end of the trip over the alloy hearth plate the work drops directly into the oil quench through a chute that makes a gas-tight seal with the furnace retort, so that the work is not exposed to the air.

At Fort Pitt Manufacturing Co. spring clips for machine gun cartridges are hardened to close tolerances in a protective atmosphere. The clips are carefully formed of spring steel, and are fed to the heat treat furnace by a Syntron vibrating feeder. The feeder shakes the pieces onto a link belt conveyor of cast alloy steel, and they are carried through the furnace in which temperature and atmosphere content are automatically controlled. At the discharge end, a sealed chute protects the work from contact with the air while dropping into the quenching oil. A second bucket-type conveyor removes the work from the quench for finishing and packing. The finished clips must be scale-free, and must pass a rigid inspection for all dimensions, so that distortion must be held to very low limits.

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Materials and Procedures for Soldering Aluminum

by G. W. BIRDSALL, Reynolds Metals Co.

Torch methods being used to seal solder spout to bottom of a tub. (Reynolds Metals Co.)

Successful soldering of relatively small assemblies is now commercially feasible provided proper solders, fluxes and techniques are used.

● SOLDERING ALUMINUM has not yet progressed to the stage where it can be done as easily as soldering steel, brass, copper or tin. However, with proper materials and methods, it is entirely practicable to join many aluminum assemblies by soldering. Size of parts being joined is the critical factor. Small parts can be soldered; large parts still await development of a practical method.

The high thermal conductivity of aluminum (almost three times that of sheet iron) makes soldering of large parts difficult. Small parts can be brought up to soldering temperature (roughly 550 to 700 F) and held there while making the joint because they will not require much heat input to raise the entire part to the working temperature. And with small parts, distortion from uneven heating is minimized. On large parts, the sections adjoining the area to be soldered will conduct heat away so fast that it is not possible to hold the working area at the correct temperature long enough to complete the joint. Also, distortion enters the picture due to aluminum's greater coefficient of expansion (double that of most other metals).

The practical limits appear to be near a maximum of 20 sq in.; that is, individual sheet metal parts whose area does not exceed 20 sq in. can be soldered together. Sections larger or thicker quickly become impractical to solder by present procedures. However, there is much development work being done to extend this

practical range. Note that while most soldering is done at 375 to 400 F, aluminum soldering range is 550 to 700 F. This, in part, accounts for the heat problem discussed above.

One method that appears to offer the most interesting possibilities is the vibrating of the work at supersonic frequencies while making the joint. This breaks up and helps remove the oxide film—a prerequisite for successful tinning, as will be explained below. However, the power output of present equipment appears to be sufficient for only small parts. Larger parts and assemblies demand greater power than available from present equipment. Thus, the development of more powerful supersonic soldering devices may extend and eventually overcome present size limitations.

Commercial and high purity aluminum are the easiest to solder. Next come the wrought aluminum alloys containing not more than 1% manganese or magnesium. The heat treatable aluminum alloys are more difficult. Soldering cast and forged aluminum parts can be done but is not generally recommended.

Most alloys for soldering aluminum contain 50 to 75% tin with the remainder usually zinc. A solder containing 60 tin and 40% zinc is frequently used. Proprietary alloys possessing a wide range of melting points are now available for soldering aluminum. (See Table)

Solders and Fluxes for Soldering Aluminum

Solder	Flux	Manufacturer
Alumaweld Special	Alumaweld All Metal	L. S. Johnson Co., 2245 South Indiana Ave., Chicago 16, Ill.
Eutecrod 199 EutecTrode 19	Eutector 199	Eutectic Welding Alloys Corp., 40-40 172 St., Flushing, N. Y.
Allen's Alumi Solder	—	L. B. Allen Co., 6759 Bryn Mawr Ave., Chicago 31, Ill.
Gardiner Aluminum Solder	—	Gardiner Metal Co., 4838 South Campbell, Chicago, Ill.
All State Aluminum Solder	—	All State Welding Alloy Co., White Plains, N. Y.
Soeffles' Flotite Aluminum Solder	—	Pittsburgh Metal Purifying Corp. Marvista & Sassel, Pittsburgh, Pa.

Removal of Oxide Coating

The principal difficulty in soldering aluminum comes from the great affinity of aluminum for oxygen. This results in the instantaneous formation of an oxide coating on any aluminum surface. Solder will not bond to aluminum oxide, so this coating must be removed before the solder can be made to bond with the underlying aluminum itself. There are two ways of removing this coating.

In one method, the most widely used, the aluminum oxide coating is dissolved and kept from re-forming by a suitable flux. This then allows the solder to bond with the underlying aluminum. The flux is also made so that it fumes or smokes as soldering temperature is reached. Thus, it acts as a temperature indicator to show when the work has attained the correct temperature for soldering.

The flux must also be fluid at soldering temperatures so that solder can easily displace it at the joint. It should produce little or no attack on the aluminum itself, otherwise there will be further chemical action from any flux not removed after soldering. Ease of removal of any residual flux thus is a valuable feature.

The other means of removing the oxide coating is the friction method. Here no flux is used. Instead, the oxide coating is broken up by mechanically abrading the surface down through an overlaying layer of molten solder. This abrading operation can be accomplished with the soldering iron or the solder itself, by simply rubbing it against the surface to be tinned. It is done more easily and efficiently, however, by using a multiple-toothed tool. Note especially that the surface to be tinned must be kept covered with molten solder while abrading. The purpose is to allow bonding of the solder direct to the aluminum surface as the oxide coating is broken up and without exposure of the fresh surface to the air.

After the surfaces to be joined have been tinned (by either method), they can be joined by sweating (heating then to a temperature at which the solder flows readily and then pressing the surfaces together and holding them together while the solder cools and solidifies).

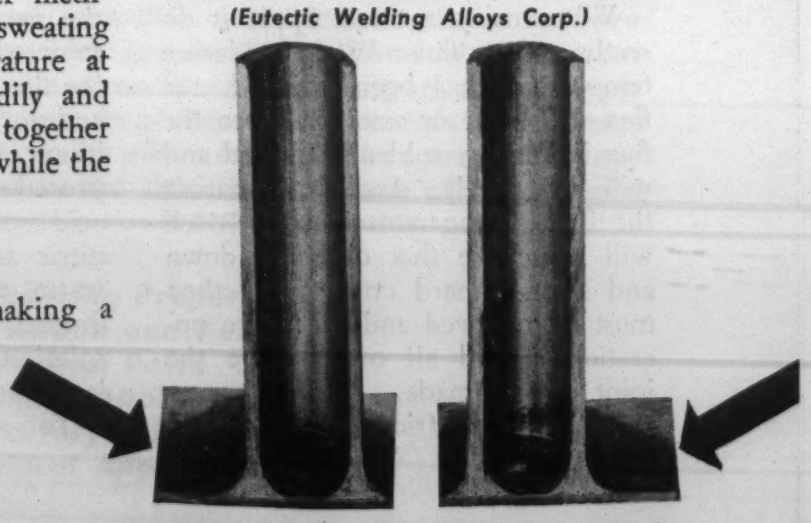
Recommended Procedure

The fundamentals of making a good soldered joint in aluminum are the same as with any other metal, with the exceptions previously noted. Surfaces must be clean and free from foreign matter and grease; the metal parts being joined must be heated above the melting point of the solder; any flux used must be molten at temperatures below the melting point of the solder and must be easily displaced by the solder to avoid entrapment in the completed joint.

Cleanliness is important. Before attempting to solder or tin the surfaces to be soldered, abrade the work areas by scraping, sand papering or wire brushing. This will remove the heavy oxide coating and leave only a thin layer to be removed by the flux or broken through in tinning.

When soldering parts of considerable mass, preheating to near the soldering temperature is recommended to facilitate the operation and help avoid distortion. Preheat-

Cross section of aluminum tubing joined by soldering shows excellent capillary action. (Eutectic Welding Alloys Corp.)



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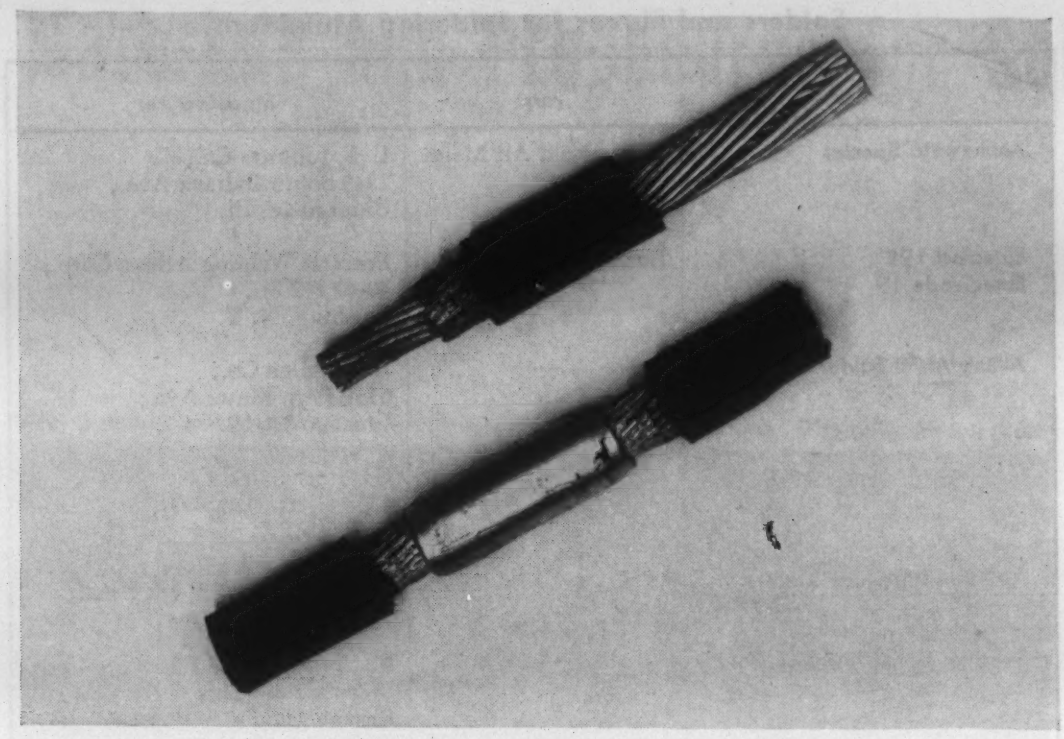


This soldered joint is now undergoing installation tests at Consolidated Edison Co. of New York, Inc. for splicing aluminum underground cables. (All State Welding Alloy Co.)

ing, when practicable, will also extend the maximum size ranges that can be soldered.

In soldering, the aim should be to apply sufficient heat to the work to melt the solder, using as little heat as possible on the solder and flux. In other words, heat the work (after fluxing) and let the work heat the solder. Heating can be done with a torch or soldering iron. If the parts to be joined are small, a soldering iron may supply sufficient heat. A soldering iron will usually be unsatisfactory because of the higher temperatures required and the great heat loss by conductivity into adjoining metal when soldering aluminum. For most parts, a torch will be preferred and large parts require it because of its larger heat output. Use a nonoxidizing flame (neutral or reducing).

The soldering alloys used with flux are known as reaction type solders. They usually melt at lower temperatures than the friction type alloys used with the friction method.

When using a torch, apply it directly on the flux. When soldering temperature has been attained, the flux will fume or smoke. When the flux is fuming, solder is applied and will flow freely. Avoid overheating the flux. Temperatures above 750 F will cause the flux to break down and form a hard crust. This then must be removed and the entire operation started all over before the joint can be made.

When using friction type solders (without flux), the heat is applied to the metal and the solder rubbed on the aluminum surface. When the proper temperature has been reached, the solder will melt and tinning will take place. If tinning does not occur, rub through the molten solder into the underlying aluminum surface and abrade this surface with a sharp tool such as a hack saw blade or a stiff wire brush. This will help break up the oxide film and raise it so it floats on the solder. In the meantime, the molten solder will protect the fresh aluminum surface from the atmosphere and so allow the solder to bond itself to this new aluminum. Instructions supplied by the maker of the solder being used should be accurately followed. It is also important to use a solder and flux designed to work together.

Where flux has been used, it is important to remove all traces of residual flux after soldering. Otherwise, corrosion will occur due to continued chemical action. One of the paramount causes of damage to soldered joints is the penetration of the flux salts into voids in the solder and into cracks between the aluminum and solder. A recommended procedure is to apply a 2% sulfuric acid solution, followed by a 1% nitric acid solution, and rinsing in warm water. Small parts can be dipped. Larger parts can have the solutions brushed on, being particularly careful to rinse thoroughly.

To solder aluminum to other metals, it is suggested that the aluminum surfaces first be tinned by either of the two methods detailed above. Then join the two metals with ordinary lead-tin solder and flux. If any difficulty is experienced, it may be well to tin the surface of the other metal before attempting to complete the joint.

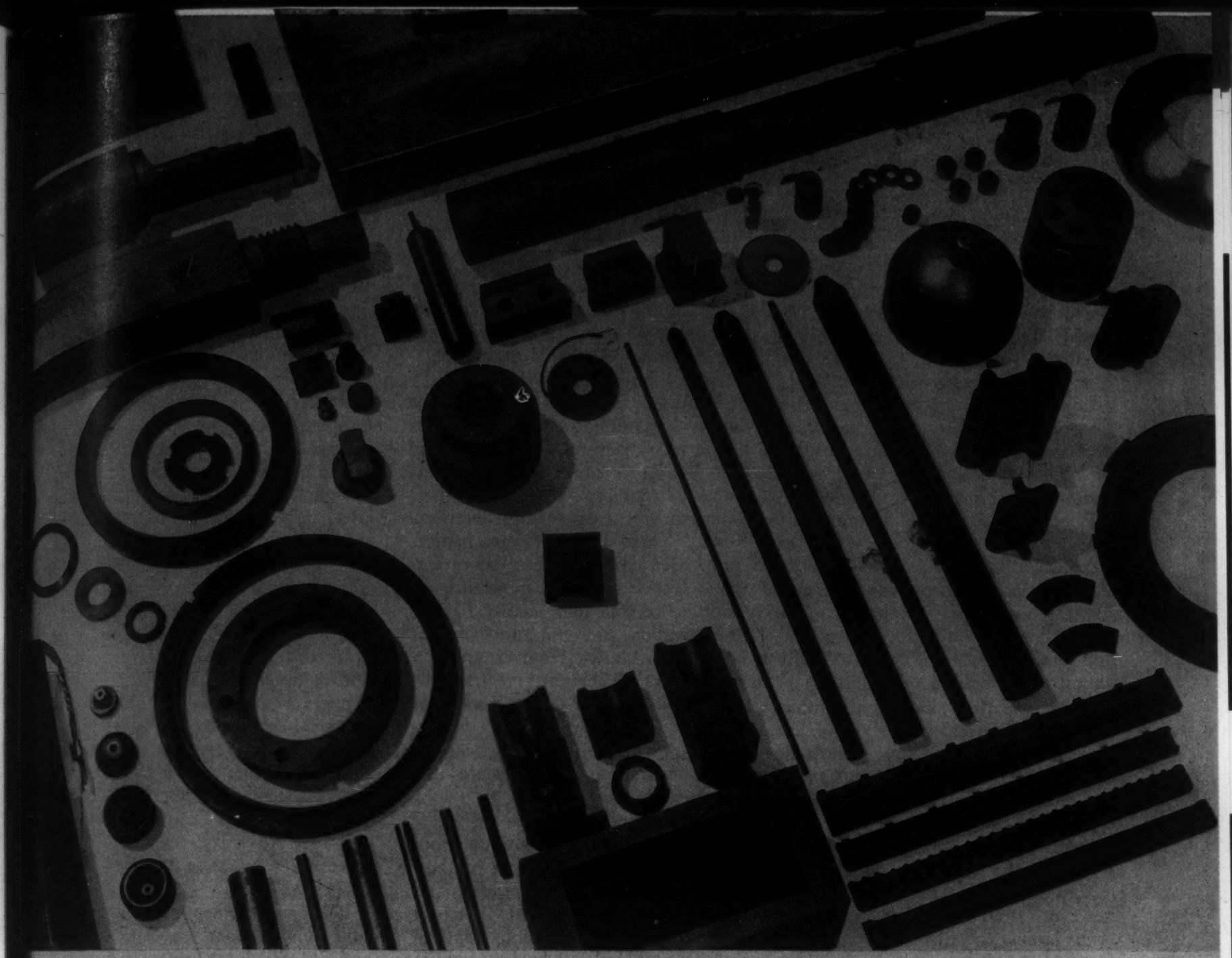
Where it is desired to solder aluminum to zinc-base die castings, difficulty may be encountered in tining the die casting. An alloy of cadmium (82.5%) and zinc (17.5%) is recommended for this application. It melts at 510 F. Tin the aluminum as detailed above, then make the joint with the cadmium alloy, or tin the die casting first and then complete the joint.

Electrogalvanic Action

An important factor in the production of good soldered joints in aluminum is taking care to prevent or minimize deterioration of the joint from electrogalvanic activity. Galvanic action occurs wherever two dissimilar metals are in contact in a solution that conducts electricity. Since all aluminum solders contain at least two other metals, there are all the elements required to produce galvanic action *if moisture is present.* As a result, a small electric current may flow, one of the metals may be dissolved and, as a consequence, holes or pits may form, reducing the mechanical strength of the joint seriously.

Where no moisture is present to form a solution, there will be no galvanic action. Also, if the metals in the joints are close to each other in the electrochemical series (have nearly the same solution potentials), the current that flows will be very small and the reaction minimized.

Therefore, if the solder joints are to be exposed to moisture, a solder which provides a minimum reaction should be selected. The tin-rich solders with considerable zinc content are often preferred for this reason. Where soldered joints in aluminum are exposed to humid or marine atmospheres, long laps or scarf joints are recommended. Where joints are subject to salt water or spray, they can be cathodically protected by attaching strips of zinc or cadmium close to the joint. In ordinary humid atmospheres or where plain water contacts the joint, it is good practice to protect the joint by a coating of moisture-proof lacquer or paint.



(Stackpole Carbon Co.)

Carbon and Graphite Materials and Parts

by Philip O'Keefe, Associate Editor, Materials & Methods

MATERIALS & METHODS MANUAL No. 81

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and applications.

APRIL 1952

A set of unique and outstanding properties are the selling points for carbon and graphite. Probably no other material has as many interesting characteristics in as many fields of product design and manufacture. There are a number of established applications of carbon and graphite materials, such as furnace electrodes, motor and generator brushes, and chemical equipment linings which have never been seriously challenged. Many new uses are being developed, too, in places where metals or ceramics were used formerly or where no other material has proved acceptable. To aid the engineer in the selection and use of carbon and graphite materials, this article covers the following points:

- ***Engineering Properties***
- ***Fabrication and Design***
- ***Mechanical Parts***
- ***Electrical Applications***
- ***Refractory Applications***
- ***Chemical Applications***

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Do you need a material that can be: (1) plunged into water from 4000 F without cracking; (2) supplied with high or low surface friction or any desired intermediate value; (3) used as an electrical conductor up to 5000 F; and (4) exposed to 4500 F without losing strength?

If these characteristics look interesting, you should investigate the possibilities of parts made from carbon and graphite. Familiar examples of such products are electric motor commutator brushes, flash light dry cell electrodes and arc lamp electrodes. These are only a few of the established uses, and new applications, replacing metals and ceramics, are now being developed. The really unique properties of carbon and graphite materials are used in almost every branch of industry.

There are three known allotropic forms of the element carbon. *Diamonds* are used in jewelry and in cutting tools. *Amorphous carbon* is the most common form of the element. It appears as the primary constituent of coal and lamp black. *Graphite,* the third allotropic form, is found as a mineral. In industry, however, this natural graphite has been largely supplanted by manufactured graphite, made by heating amorphous carbon for long periods. The change from amorphous carbon to graphite is a process of crystal growth or crystal perfection. Commercially, the low temperature form of the element is known simply as "carbon," as differentiated from graphite.

Parts and structural materials are made of carbon or graphite, or combinations of both. The powdered raw materials are mixed with a carbonaceous binder like tar and molded or extruded to the shape desired. The "green" pieces are then fired in furnaces. In firing, the binder is converted to carbon or graphite by the high furnace temperatures. Thus, the finished product is homogeneous, with no deleterious foreign binder.

Products made in this way have some outstanding properties. In some ways, they resemble electrically conducting ceramics. Like conventional ceramics, they keep their strength at extremely high temperatures. They also have mechanical properties similar to those of ceramics. Good chemical resistance is another ceramic-like quality. However, carbon and graphite materials are quite different from ceramics in some ways. They react with air or oxygen at elevated temperatures, for instance. Another contrast to ceramic properties is the high resistance of carbon and graphite materials to thermal shock.

The commercial value of these materials lies in these unique property combinations. In most of their conventional applications, carbon and graphite present the only practical or even the only possible solution to the problem involved. Most of the recent uses of carbon and graphite and their applications as alternate and substitute materials also stem from the same special properties. In bearings, sealing rings, pump parts and clutch shoes, anti-friction and long-wearing properties and dimensional stability are the selling points. The resistance of carbon and graphite to chemical attack makes them suitable for pipes, fittings and surface facings. As refractories, these materials are used in metal and glass molds, blast furnace linings and melting crucibles. The special electrical properties—good conductivity, arc stability and high temperature resistance—are valuable in electrodes, contact tips, motor and generator brushes and welding rods.

Another valuable engineering characteristic is that most of these properties can be varied over considerable ranges to fit the need. Chemical and electrical properties are altered for different applications. Mechanical values—strength, hardness and friction characteristics—can be tailored to fit requirements over an even wider range. The raw materials and their refining methods are one source of these variations. The two forms of the element, carbon and graphite, also show different properties. Carbon, for instance, is a good heat insulator. Graphite, on the other hand, is a better heat conductor than many metals. Blends of the two stand between them in this respect. On top of this, the methods used to make the parts themselves can vary, affecting the finished properties.

These variations make it impossible to give complete, specific data and general design rules. There are no national standard grades with fixed compositions and tabulated properties. Most of these materials are supplied under trade names. The best way to think of their properties is in terms of available ranges. The most logical introduction to carbon and graphite is a survey of the most important fields of application, with consideration of the advantages and limitations in each product.

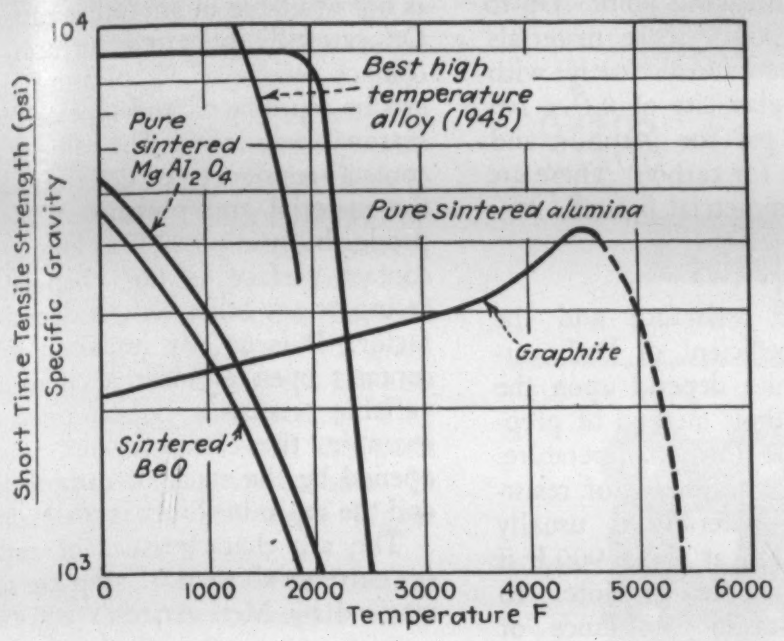
Properties of Carbon and Graphite

Carbon is particularly interesting since it is one of the transition elements, with many of the characteristics of both metals and nonmetals. The most important properties of carbon and graphite materials are inertness to chemical action, good high temperature strength, excellent resistance to thermal shock, high sublimating or boiling points, good heat conductivity, high heat of vaporization, and good arc characteristics and electrical conductivity.

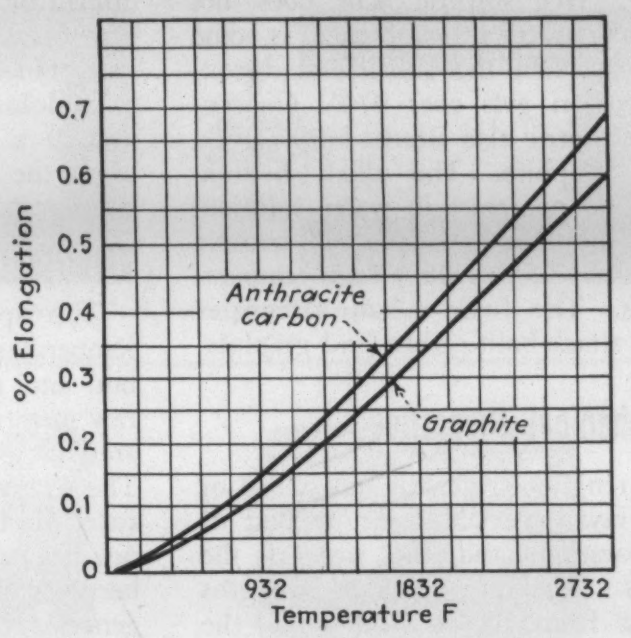
Physical Properties

The international atomic weight of carbon is 12.01. There are two isotopes of the element, of mass number 12 and 13, in the proportions of 99.3 and 0.7%, respectively. The density of a single crystal of graphite is given as 0.0813 lb per cu in. All industrial materials have some porosity, however, and the density of industrial graphite varies from 0.0556 to 0.0596 lb per cu in., while industrial carbon densities range from 0.0542 to 0.0632 lb per cu in. These densities are somewhat less than that of glass, and about one quarter that of iron.

The high temperature properties are of interest in choosing materials for refractories, welding tips, furnace electrodes, electrical contacts and other applications. The heat conductivity of carbon is 2-8 Btu/ft/hr/° F, and that of graphite is 60 Btu/ft/hr/° F. These values compare



Strength-to-weight ratio of one grade of graphite compared to values for other materials. Graphite retains its strength far above the temperature at which even pure sintered alumina becomes unsatisfactory. (Malmstrom, Keen and Green, "Journal of Applied Physics," May 1951.)



Longitudinal thermal expansions of fabricated carbon and graphite. (National Carbon Div.)

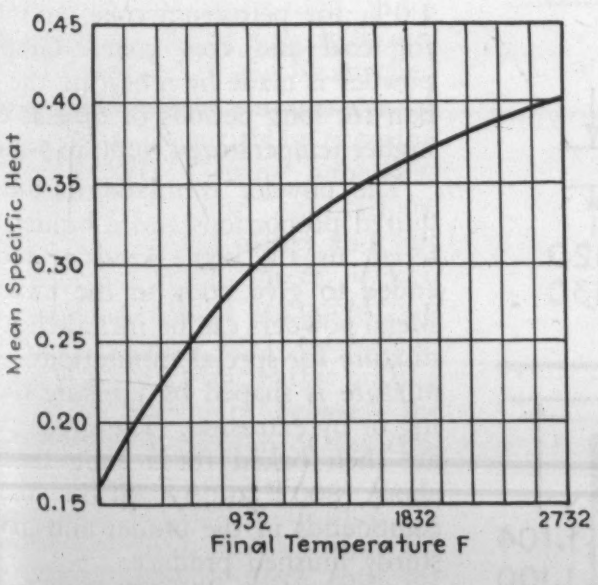
with 243 for silver, 224 for copper, 27 for gray iron, and 85 for tungsten and molybdenum. The linear coefficients of expansion per °F for carbon and graphite are 1.5×10^{-6} and 1.0×10^{-6}, compared to 2.3×10^{-6} for porcelain and 2.8×10^{-6} to 5.6×10^{-6} for glass. The total emissivity of carbon at all temperatures is 0.80, compared to 0.035 for silver at 1800 F, 0.13 for polished molybdenum at 1800 F, 0.26 for magnesia at 1450 F and 0.52 for zircon at 1450 F.

Chemical Properties

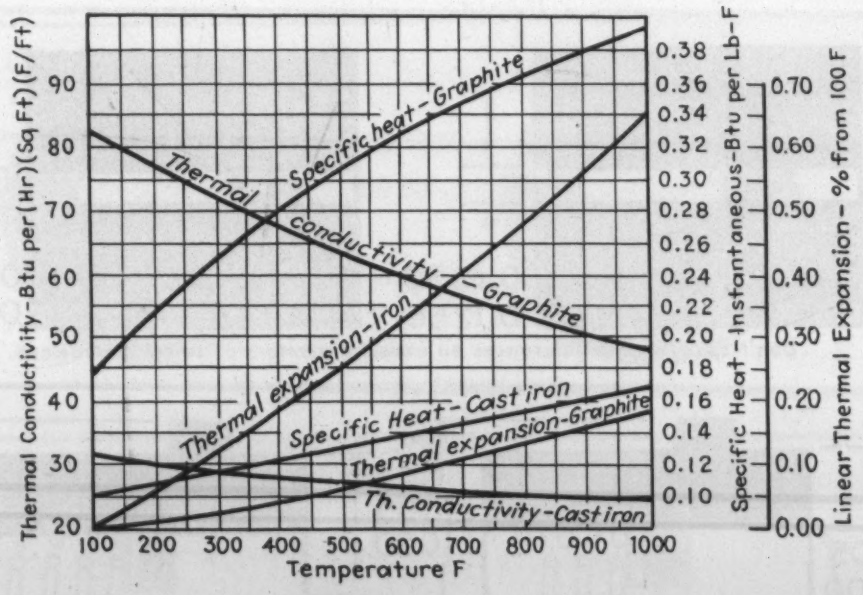
Carbon does not react with hydrogen at ordinary temperatures. At 2000 F, however, a small amount of methane is formed, and the reaction can be accelerated by a platinum catalyst. With a nickel catalyst, the reaction takes place at about 900 F.

At ordinary temperatures, carbon seems to absorb or adsorb some oxygen. In excess air, carbon begins to oxidize at 630 F and graphite at 810 F. These temperatures vary with the material, to some extent. The rate of oxidation is not rapid, even at high temperatures, and the products of combustion are gases. Neither carbon nor graphite materials support combustion. With steam or CO_2, temperatures over red heat may bring excessive oxidation. The operating limits for carbon are given as 1100 F for steam and 1300 F for CO_2.

As a general rule, these materials do not react with most acids or al-



Mean specific heat of carbon-graphite between 68 F and the final temperature indicated. (National Carbon Div.)



Comparison of the thermal properties of one grade of graphite with those of cast iron. (National Carbon Div.)

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kalies. Hydrofluoric acid has no effect. Hot sulfuric acid does not usually react, although there is some attack when the sulfuric acid concentration gets over 97%. Concentrated nitric also attacks both carbon and graphite. The alkali hydroxides do not react in water solution, but the fused compounds become corrosive at extremely high temperatures. The fused alkali carbonates also attack both carbon and graphite.

Mechanical Properties

Strengths vary with the source of the raw materials, their method of preparation, and the size of the parts. Carbon flexural strengths range from 500 to 12,000 psi; the flexural strength of graphite ranges from 800 to 4500 psi. Surface hardness readings on carbon and graphite are subject to wide variations. In elastic properties, carbon and graphite materials behave much like glass and other ceramics; there is no yield point, and the elastic limit is determined by the breaking point. Up to the breaking point, these materials obey Hook's Law fairly closely, with a modulus of elasticity of 0.6×10^6 to 1.9×10^6 psi for graphite and about the same for carbon. These are all nominal commercial figures.

Electrical Properties

The specific resistance and the temperature coefficient of both carbon and graphite depend upon the raw materials, their method of preparation, and the firing temperature. The temperature coefficient of resistance of both materials is usually negative, although at about 900 F it becomes positive for graphite. In general, the specific resistance of graphite varies from 300×10^{-6} to 500×10^{-6} ohm-in. The values for carbon range from 1000×10^{-6} to 2000×10^{-6}. In contrast, the corresponding figures for common metals range from 0.64×10^{-6} for silver to 3.94×10^{-6} for iron.

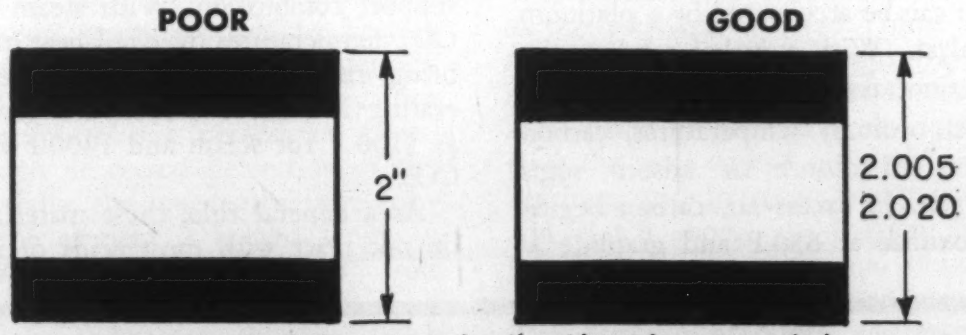
Carbon has one characteristic that is not available in any other material. On carefully prepared surfaces, the contact resistance vs pressure curve can be reproduced and repeated with reasonable accuracy. The value of this contact resistance is determined by the material and pressure. This reproducibility is possible as long as the contact surface is not changed by arcing or any other serious disturbing factor. It is usually impaired if the contacts open or close a circuit. In variable resistance carbon piles, for example, the circuit is not usually opened by the stack of carbon disks and the reproducibility is maintained.

The arc characteristics of carbon for currents above 0.01 amp are summarized by Mrs. Aryton's equation:

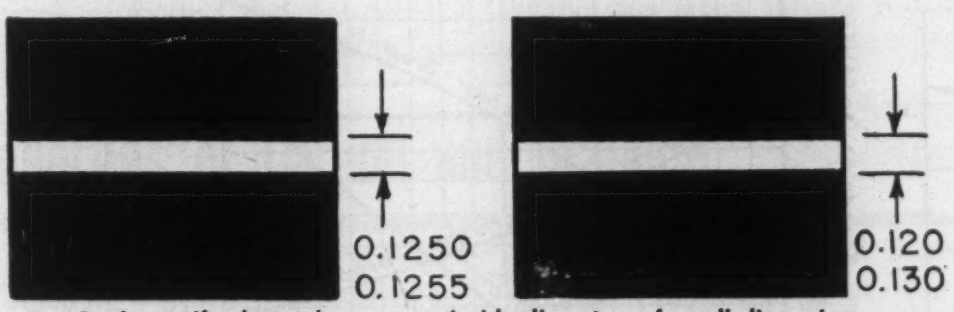
$$V = a + bl + \frac{c + dl}{I}$$

where I = current; V = arc voltage; l = arc length; a = 38.9; b = 2; c = 16.6; d = 10.5

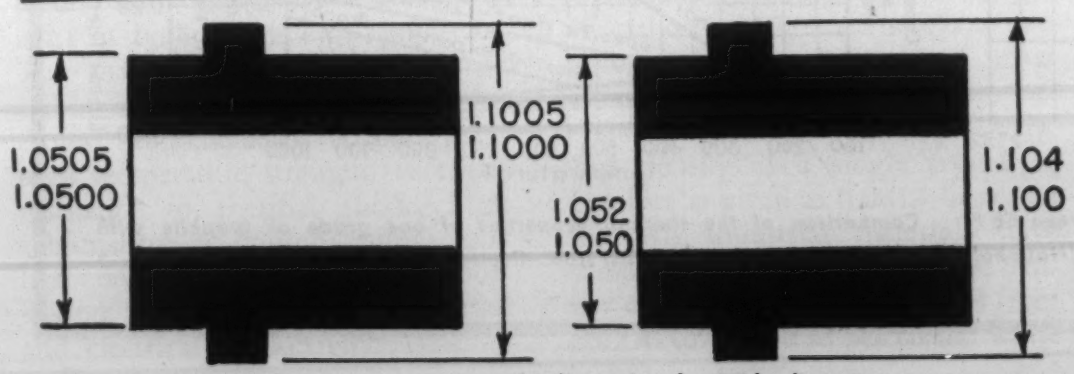
Fabrication and Design



Don't use rough dimensions. Specify widest tolerance practical.



Don't specify close tolerances on inside diameters of small dimensions.



Avoid close tolerances on multi-dimensional outside diameters.

The first step in the fabricating process is obtaining the carbon or graphite powder. Carbon powder is made from various kinds of cokes and blacks. These are calcified at white heat to drive off volatile contents and then pulverized to carbon powder. The residual ash content, which depends on the coke or black used, determines the quantity of the powder. Ash contents average 0.1% for blacks, 1.0% for petroleum coke, and 10% for coal and coal coke. Graphite powder is made by reheating the carbon for long periods of time at even higher temperatures, 4000 to 5400 F.

The powder is mixed in the required proportions and a binder material, usually some kind of tar, is added to give body to the mixture. Metal powders can be included in the mixture for special applications. The mixture is shaped by pressure molding or by extrusion. The green parts are then baked for a long time at about 1800 F to drive off the volatile compounds in the binder and give a sturdy finished product.

The baked material is more or less porous, depending on the manufacturing processes. This porosity varies from about 0.5 to 32%. The size of

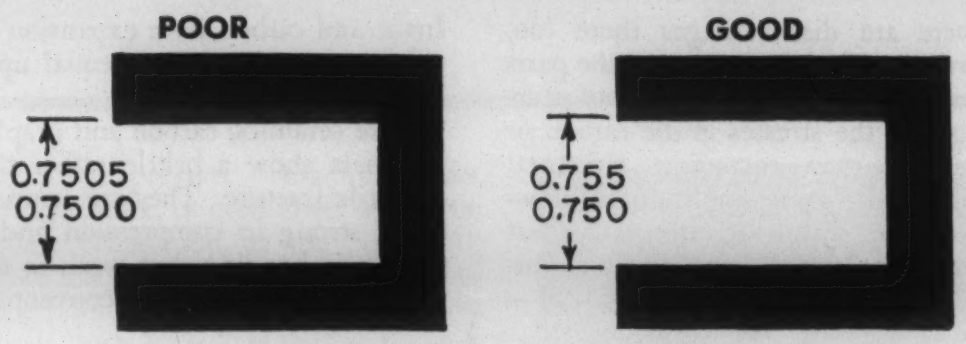
the pores can be controlled in manufacture, and they can even be made continuous so that the product can be used for filtration, aeration or diffusion. The pores can also be impregnated with tar or thermosetting resins to make the material impervious to liquids and gases. For special applications, waxes, special oils, greases, chemicals or metals like babbitt, cadmium, copper or silver can be used as impregnants. The size of the grain in carbon and graphite parts can also be controlled in manufacture. Fine grains are desirable when the parts must be machined, for example. In general, larger parts have bigger grains.

In baking, the material shrinks somewhat and these possible variations in shrinkage prevent molding some parts to size directly. A good molding tolerance on most dimensions is 2%. If the dimensions must be held closely, the baked materials are ground or machined to size. With these methods, small parts can sometimes be finished to dimensional tolerances as close as 0.0005 in. If a high degree of flatness is required, lapping and polishing can be used to get accuracies within a few millionths of an inch. Machining is usually done dry, although oil or water are sometimes used.

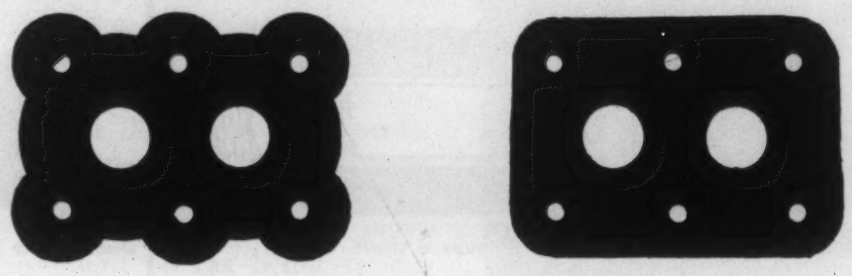
Finishing operations often cause slight chipping on sharp edges. If this is not allowable, the edges can be broken by a chamfer. In any case, the chips are small, approaching the size of the original particles. They do not affect the operation of the part and should not be regarded as being as deleterious as are chips in metal.

Parts can be joined to other materials in a number of ways. Mechanical fasteners are not usually used. Rubber can be vulcanized directly to carbon and graphite, or can be attached by adhesives. Metal surfaces can be joined to these materials by pressure-setting or thermosetting adhesives. For low temperature applications, parts can be copper plated and soft soldered to metal pieces. High melting point solders are not recommended, however, since the assemblies may warp or crack after brazing due to the difference between the coefficients of expansion of the copper and the other metal.

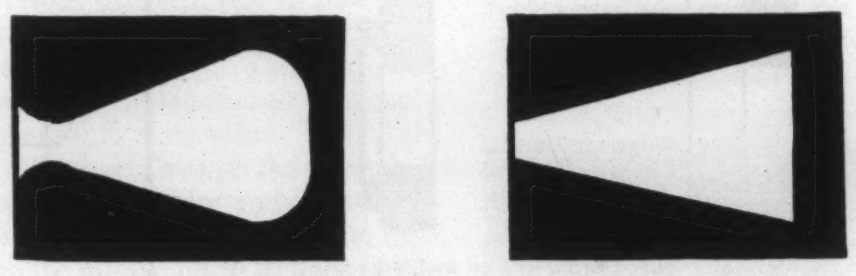
A better assembling method for high temperatures is to shrink the carbon or graphite piece into the metal. The shrink is regulated so that the carbon piece is left in stress at the highest temperature at which the assembly is designed to operate.



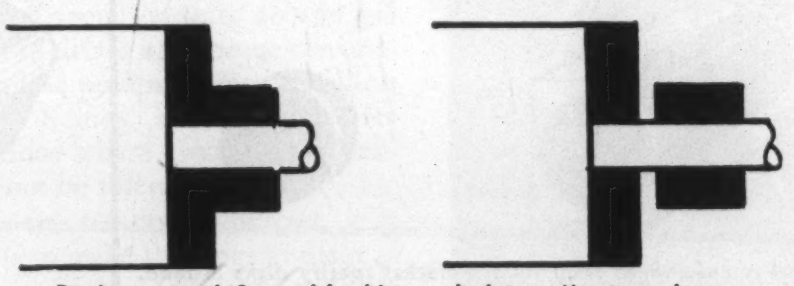
Do not specify close limits on blind holes.



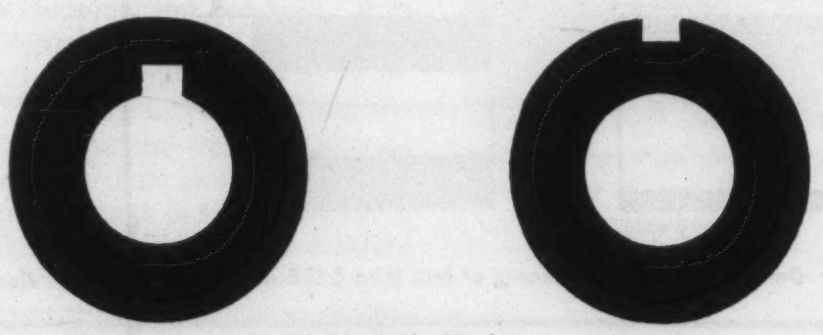
Don't specify intricate external shapes.



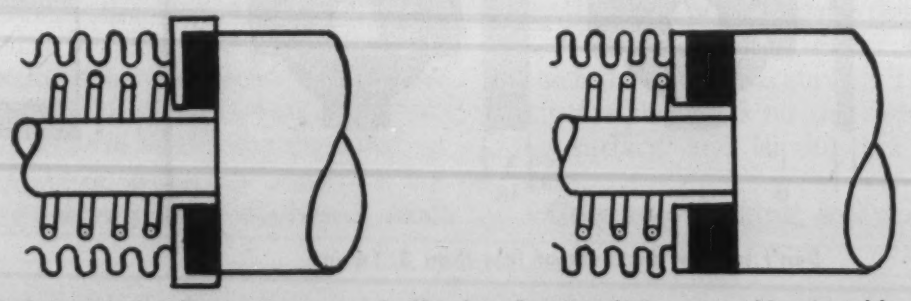
Do not specify intricate internal shapes.



Don't use weak flanged bushing-end plates. Use two pieces.



Don't specify ID slots.



Don't press, shrink or cement a seal. Use free floating design or cushion in rubber.

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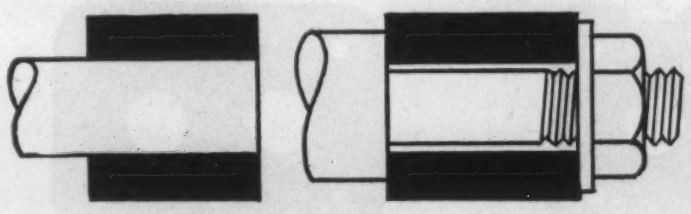
There are disadvantages there too, however. The dimensions on the parts must be held closely in manufacturing, and the stresses in the carbon or graphite may encourage structural failure. In some applications, however, the distorting effect of heat changes on shrink joints may be minimized by using Invar as the metal—Invar and carbon have expansion coefficients that are nearly equal up to 600 F.

Like ceramics, carbon and graphite materials show a brittle rather than a ductile fracture. They are comparatively strong in compression and in transverse bending, but weak in tension. Many of the design conventions are based on the limited impact resistance of the materials. Tapped holes, developed shapes, thin flanges, corrugations and keyways are not desirable. Threads are not usually specified, although large carbon and graphite electrodes are threaded successfully. Thin, complicated sections should be avoided.

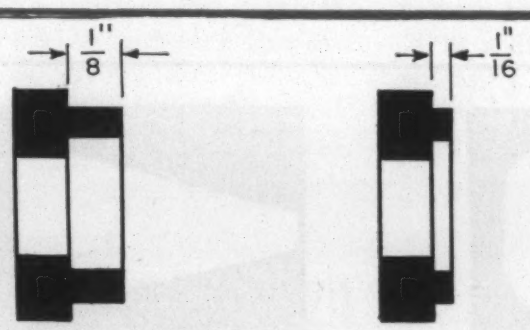
POOR **GOOD**



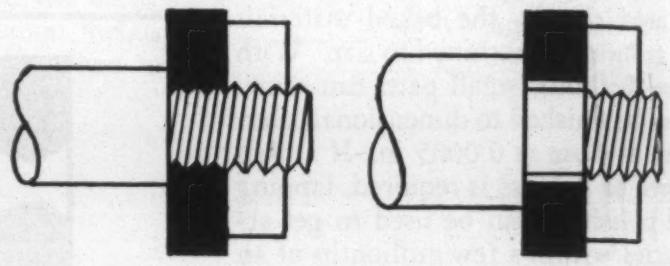
Don't plan to press-fit over a shaft.

POOR **GOOD**

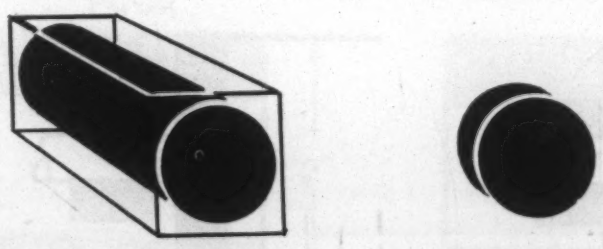
Don't make seals from blank bar stock. Let manufacturer finish pieces.



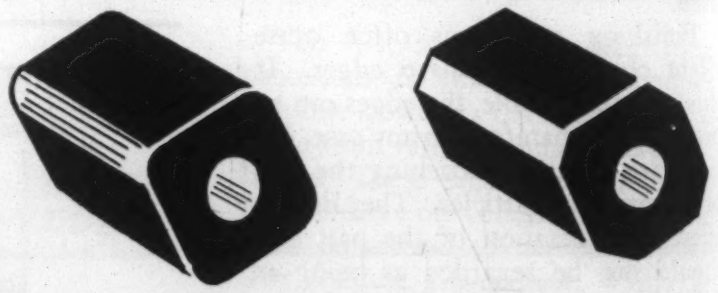
Do not specify long necks on molded seals.



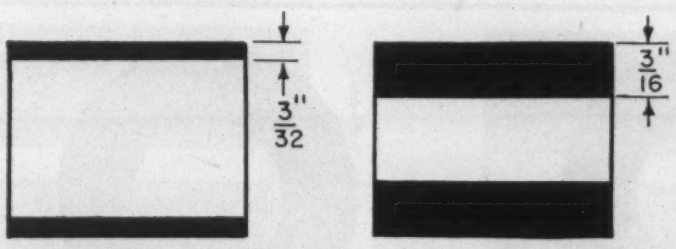
Do not specify threads in graphite.



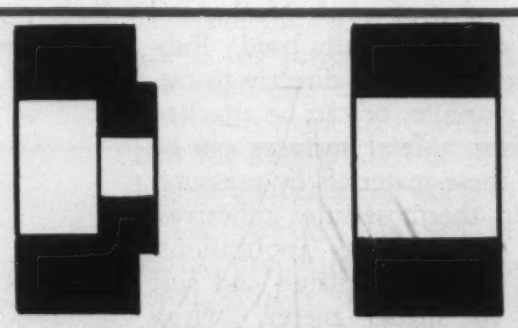
Do not cut round shapes from square blocks; specify disks instead.



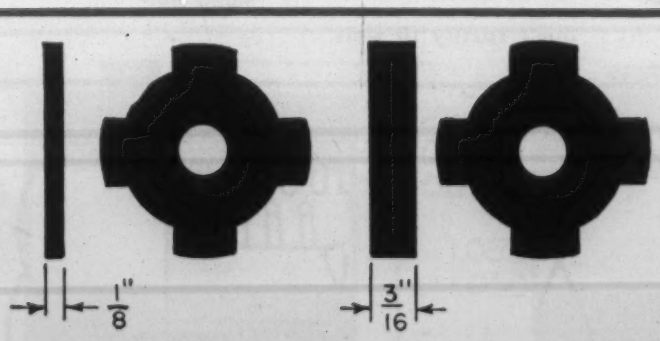
Use a chamfer edge, not a radius edge.



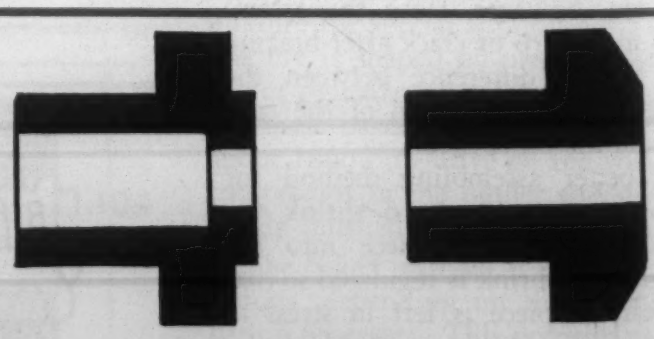
Don't specify wall thickness of less than 3/16 in.



Don't design uneven or counterbored rings for lapping.



Don't specify thickness of less than 3/16 in.



Don't specify intricate cross section.

(United States Graphite Co.)

Mechanical Parts

The fastest growing family of applications of carbon and graphite is in mechanical parts for machinery. Sealing rings, bearings, pistons, piston rings, valve parts and pump blades are made from carbon and graphite. The low friction losses of these materials and their low rate of wear running against metal are the important properties here. The chemical and thermal properties are also valuable in some cases.

Mechanical parts are usually molded directly, then machined or ground to meet dimensional tolerance requirements. Some parts are machined from extruded stock, however. Various mixtures of carbon and graphite are used for particular applications, and the material can be porous or nonporous.

Seal Rings

Carbon and graphite composition seal rings are used to contain liquids and gases at moving shaft joint faces. The surface riding against the metal takes on a polish, and particles of graphite adhere to the metal, decreasing wear. These seals may operate against steel, bronze, brass, zinc, Nitralloy and monel wear plates. The flatness of the surface of the seal ring is extremely important in some applications and extremely close tolerances must often be held. In general, the harder the material, the lower its running friction and the easier it is to hold to close tolerances.

Porous seal materials are used to seal liquids at low pressures. The pores, which are connected by devious paths, can, under pressure, allow a limited flow of liquid or gas. With low pressure oil, grease or water seals, the slight seepage of liquid gives lubrication without objectionable leakage. Examples of seals where porous carbon and graphite can be used successfully are bearing and gear box seals, certain types of centrifugal pump seals, and propeller shaft seals on boats. The grades in this class have various degrees of hardness, porosity and other characteristcs which fit them for various uses. Pressures handled by porous seals are not usually over 35 to 40 psi.

Semi-porous seal rings are made of material with the pores almost completely filled. This material is generally considered to be impervious up to 50 psi pressure. However, under this pressure, or even lower pressures, some penetration of the pores will take place, and in time a few drops of the liquid will seep through. In most seals, such leakage is unobjectionable or is even desirable. Even a small amount of lubrication will materailly lower the coefficient of friction, thus enabling the seal to operate at higher speed and pressures.

Completely impervious materials are used for drop-tight seals operating at high pressure. Usually a double furnacing is used to seal the pores and there is no penetration of the pores by the liquid or gas being sealed. Generally speaking, these seal materials will not stand as high a pressure or speed as the porous or nearly impervious material, due to complete absence of lubrication through the pores of the carbon. This does not mean that some lubrication surrounding the seal is of no value. The lubricant cannot get through the pores, but it does serve to carry away heat, and some of the liquid will reach the face due to the minute imperfections in the seal surfaces and to capillary attraction. Impervious materials are being used in refrigeration seals, air and gas seals, fluid drives and torque converters, gasoline pumps, pumps handling corrosive liquids, and many similar applications where even minute leakage cannot be tolerated.

From the standpoint of cost, it is desirable to make the rings as plain as possible. Each additional grinding operation adds to the cost, not only for the operation itself, but in rejects due to chipping and breakage. It is often desirable to use a narrow seal face, often as small as 1/16 to 1/8 in. wide. The engineer should not attempt to make the wall thickness of the ring this thin, as the material is not strong enough in such thicknesses, and additional cost would be incurred due to breakage in grinding rings. In such cases the engineer often designs the ring with a larger section and then puts one or two shoulders on it to reduce the contact area. In most cases, however, the lowest cost comes in leaving the ring plain and putting the shoulders on the metal mating surface. No chipping or breakage losses will occur in machining the metal.

Another difference comes in lapping the two parts. Carbon is much easier to lap than metal, and there is no appreciable difference in the cost of lapping a shouldered or unshouldered ring. With metals, the shouldered ring is much easier to lap, which is another argument for putting the shoulders on the metal mating surface, and leaving the carbon plain.

Generally speaking, seal rings can-

Fairly complicated parts like this seal ring are finish machined to final shape. (Morganite, Inc.)

Sharp edges will often be broken by tiny chips. These chips do not affect the performance or strength of the part, however. (Morganite, Inc.)

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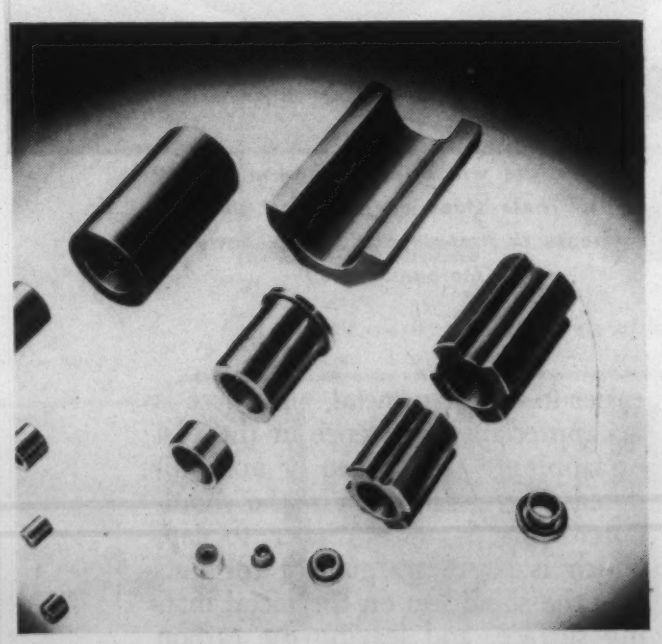
not be molded to the finished size, except where wide tolerances are given. The material is either molded into blocks and cut to size or is molded into an oversize piece and machined to the final dimensions after firing.

Carbon is not as easily held to close tolerances as metal parts. Tolerances should be as liberal as the related parts will allow in order to hold down the cost. Tolerances of 0.000^5 in. can be held on rings, but such tolerances cause numerous rejections, which add to the cost. Experience shows that a total tolerance of 0.004 in. can be maintained on machined dimensions without much slow-up in production or excessive rejections of finished parts. A larger tolerance is desirable where it can be given, but generally speaking 0.004-in. tolerance will not cause any appreciable increase in cost. Tolerances closer than 0.004 in. will push prices up.

Rings are generally stationary and are held from rotating by a slot or projection from the ring. The latter is preferable from the standpoint of strength, as a slot cuts into the body of the ring, weakening it. On the other hand, a tab or projecting ear is expensive to machine and is, therefore, not practical on small quantity lots. On large production jobs, the tabs can usually be molded, especially on designs where the tolerance on dimensions is 1½% or more of the dimension. The thickness dimension is always ground so tolerances on this dimension are not important from the standpoint of molding to size.

Bearing Materials

Carbon and graphite bearings are used where temperatures are high, where lubrication is impractical or impossible, and where corrosion or chemical action rules out other materials. They are not general-purpose bearing materials. They are used mostly in bearings that must run dry or submerged. Chemical resistance makes them ideal where the liquid handled must act as the lubricant. The porosity of the material tends to hold lubricants and the graphite itself gives low friction.



Carbon bearings are recommended for dye vats, immersion rolls and general textile service. (Morganite, Inc.)

Hardened materials are preferred as shafting. Stainless steel, heat treated monel and even cold rolled steel can be used successfully on most slow and medium speed applications. Shafting (or any material running against carbon and graphite) should have as smooth a surface as possible. These bearings are often shrink-fitted, pressed or cast into metal housings. The interference in shrink and press fits canot be too large.

The strength and friction characteristics of the various commercial carbonaceous bearing materials vary, and no one set of selection charts can be given. The procedure is generally the same, however. First, the minimum bearing wall thickness, which is proportional to the shaft diameter, is chosen from graphs. The press or shrink fit is also taken from tables for the particular material and checked to make sure the bearing will not come loose at the operating temperature. Charts are also available to give the clearance for each shaft size. The running clearance and the close-in from the shrink or press housing fit are added to the maximum shaft OD to give the proper average bearing ID.

The allowable bearing pressure varies with the material, the shaft size and the shaft speed. Pressures up to 800 psi with lubrication and up to 160 psi without lubrication can be used with one representative material. The smaller the shaft, the higher the allowable pressure on the projected bearing area, all other factors being equal. The faster the rotation, the lower the allowable pressure.

Dash Pot Plungers

A unique application of graphite is its use for dash pot plungers. The ideal plunger gives a frictional force proportional to the velocity of the motion. With a slowly moving plunger almost no frictional force should be observed. Graphite comes closest to fulfilling these requirements. The static friction of graphite is not much higher than its sliding friction, so that there is almost no sticking. The cylinder and plunger dimensions and the size of the air orifice can be designed to make the resisting force proportional to velocity. Since graphite does not require liquid lubricants, the dash pot is not affected by temperature changes.

Piston and Piston Rings

Carbon and graphite composition pistons and piston rings find wide use in nonlubricated compressors handling such fluids as steam, oxygen, air, carbon dioxide and hydrogen sulfide. In some cases, carbon is used because of the corrosive conditions involved. In other applications, the fluid cannot be contaminated and the piston must run dry. The designs used vary. Some carbon-graphite pistons have piston rings of the same material. Precision finished pistons run without rings at speeds up to 6000 strokes per min. Carbon-graphite pistons have also found wide acceptance in metering devices handling corrosive chemicals. Chemical inertness and dimensional stability insure minimum wear in installations which require maximum accuracy.

Pump and Valve Parts

Disks, pistons, end plates and other parts for valves are another application of carbon graphite parts. The dimensional stability and corrosion resistance of the materials is of paramount importance here. In many of these applications, the ability to run without lubrication is also important because the fluids handled cannot be contaminated. In some valves, the light weight of the carbon parts is advantageous in keeping the units sensitive.

Carbon-graphite blades are used in compressors and pumps handling air, Freon and chemical gases. These blades require no lubrication and give long service.

The chemical industry also uses pumps made entirely of carbon and graphite. Centrifugal pumps of the semi-enclosed impeller type are the most common. All the parts of the pump that come in contact with the corrosive liquids are made of an appropriate type of carbon or graphite. The pumps are specially designed to avoid leaks without the use of stuffing boxes or flexible seals. Corrosion resistant globe valves are also made of carbon for special applications. Steam jets made of carbon are another pumping method that can be used for highly corrosive vapors.

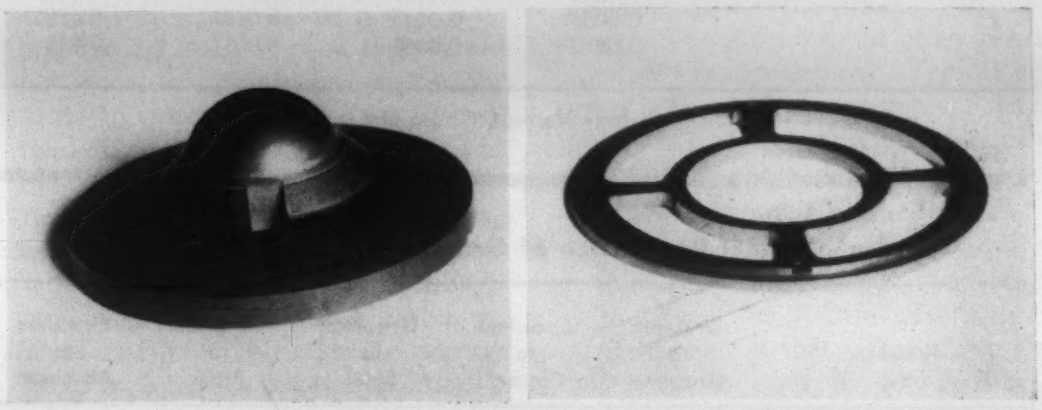
Electrical Applications

Some of the oldest uses of carbon and graphite parts are in the electrical field. While their electrical conductivity is not outstanding (in comparison to some metals at least), they have chemical and heat resistance that make them valuable for special jobs. Carbon and graphite are actually the only refractory conductors known.

Electrodes

The largest single use of molded and extruded carbon and graphite is in electrodes. Amorphous carbon electrodes, lower in electrical conductivity than the graphite electrodes, but also somewhat cheaper, are used extensively in electric arc steel furnaces, and in making phosphorus, ferroalloys, and calcium carbides. Graphite anodes are used in electrolytic work, where their low resistance and long life are valuable. Typical applications are in the production of chlorine, aluminum, magnesium and sodium, the chlorination of gold ores, the recovery of copper, nickel and zinc, and the manufacture of hypochlorites. Both these materials are well suited to this electrode application. They are good conductors, but unlike most conductors, do not melt. They are good refractories, but unlike most refractories, do not disintegrate when subjected to thermal shock. They are also much stronger and less brittle than most nonmetals.

Carbon arc-light electrodes are used to carry electric arcs. Two of these electrodes are brought together to allow a heavy current to flow. When the electrodes are separated to the operating distance of $\frac{1}{4}$ in. or more, the heat generated by the current volatilizes enough of the carbon to maintain an arc through the carbon vapor. These electrodes are much smaller than those used in electrolytic and electrothermic applications. Arc carbons are usually less than 1 in. in diameter and less than 2 ft. long. Unlike the larger electrodes, they are not homogeneous, but have special cores inside the baked carbon shell. These cores give better arcing qualities by insuring a supply of irons in the arc. The cores also affect the wave length of the emitted radiation. Carbon electrodes are used in search lights, motion picture projectors and other high intensity sources. They are also used in laboratories in spectrographic analyses. Therapeutic lamps are another big application.



These meter parts are indicative of the complexity of shape attainable in carbon parts. (Pure Carbon Co., Inc.)

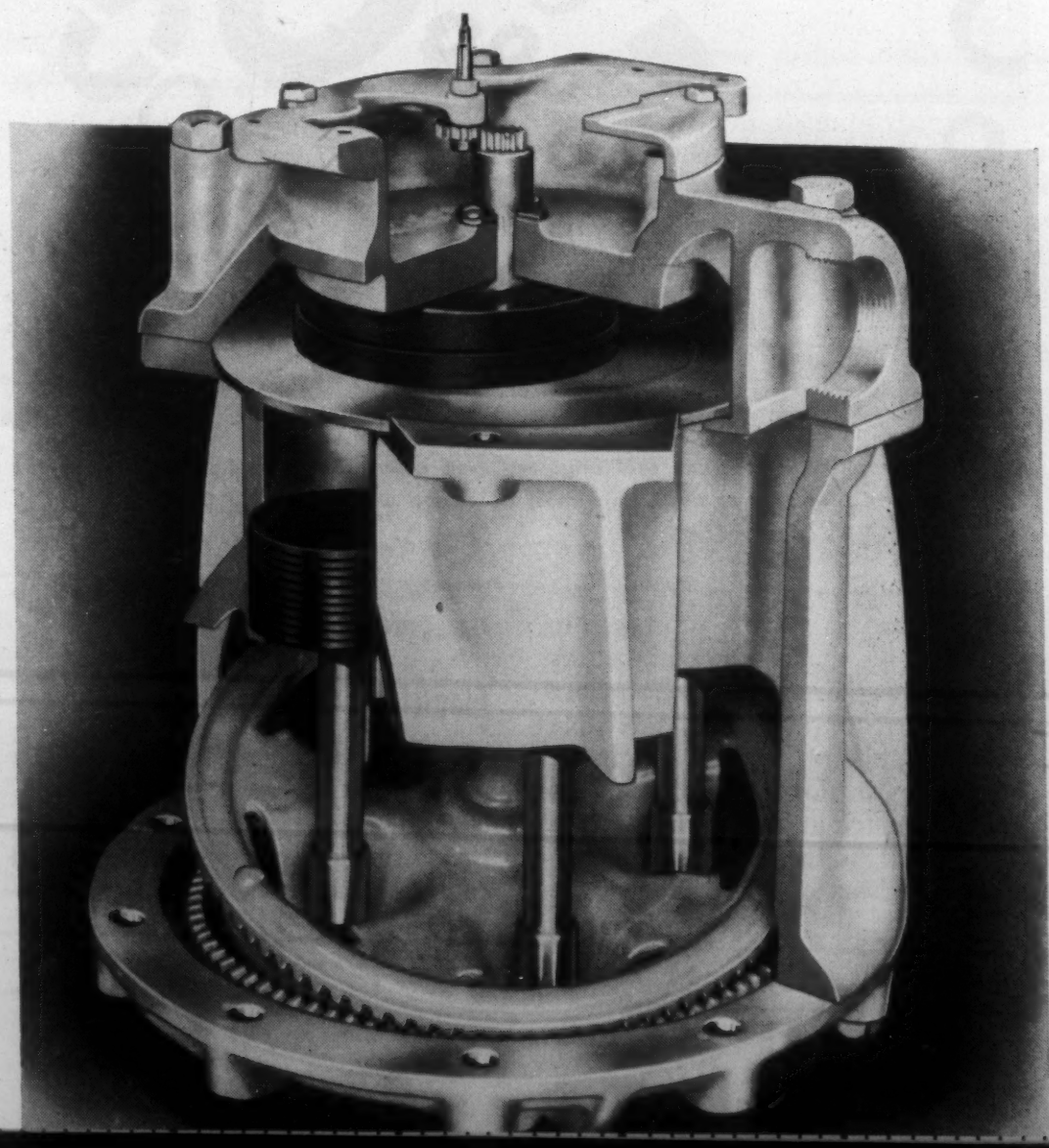
Ground Rods

Carbon ground rods for electrical circuits and for cathodic protection of underground structures are extremely durable. They are not attacked by any corrosive soil conditions; they do not crack or spoil in soil which freezes and thaws repeatedly. The ground rods are placed at intervals along the pipe line or structure to be protected, and a low potential direct current is applied between the metal and the anodes.

Battery Carbons

Small carbon rods are also used as electrodes in wet and dry cell batteries. The carbon is used only as a conductor in these cells, and does not enter into the cell reactions. The main

Carbon-graphite seal rings and pistons are used in metering devices handling corrosive chemicals. Dimensional stability, chemical resistance and wear resistance insure meter accuracy. (United States Graphite Co.)



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Typical Contact Resistance of Carbon in Ohms for 1 Sq In.

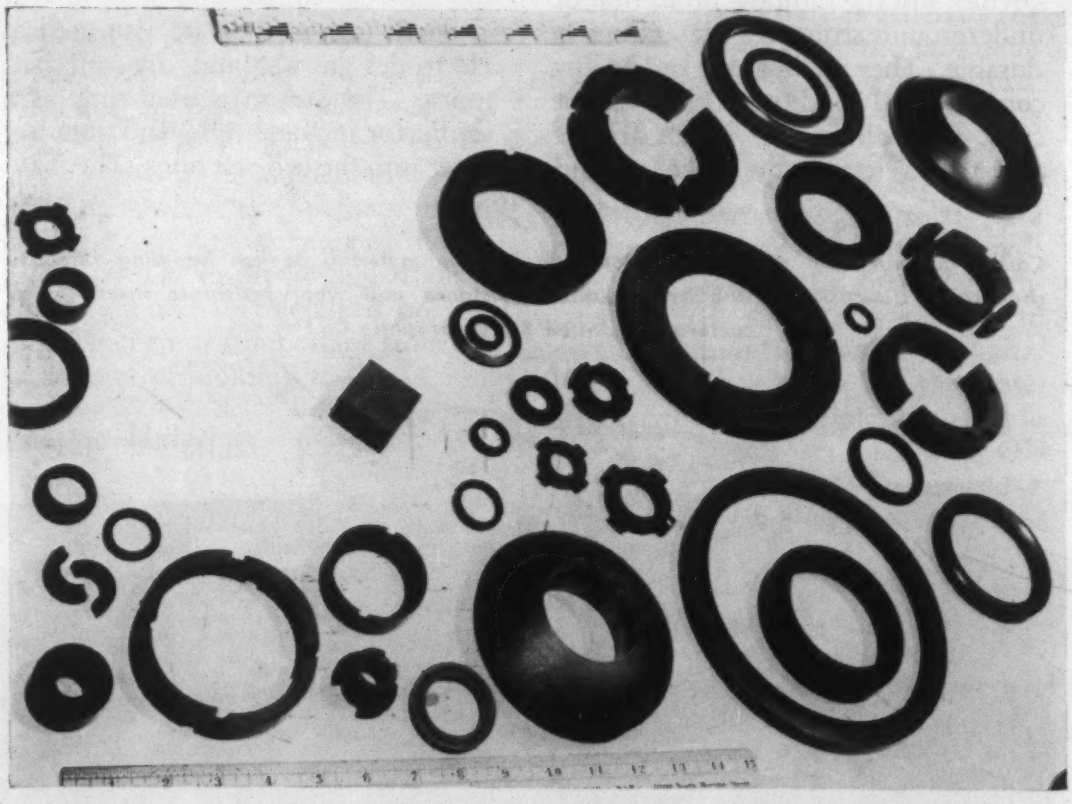
Pressure, Psi	Carbon to Carbon	Carbon to Copper	Carbon to Brass	Carbon to Aluminum
5	0.0058	0.0133	0.038	0.138
25	0.0026	0.0093	0.012	0.078
75	0.0017	0.0042	0.0052	0.015

Courtesy National Carbon Div.

Typical Contact Resistance of Graphite in Ohms for 1 Sq In.

Pressure, Psi	Graphite to Graphite	Graphite to Copper	Graphite to Steel	Graphite to Brass	Graphite to Aluminum
25	0.000473	0.000704	0.01309	0.00092	0.0448
75	0.000261	0.000424	0.00694	0.000345	0.0159
150	0.000175	0.000315	0.00438	0.000214	0.0067
250	0.000101	0.000237	0.00282	0.000162	0.0043
400	0.000064	0.000162	0.00177	0.000109	0.0020
750	0.000036	0.0000755	0.000856	—	—
1000	0.000031	0.0000555	0.000737	—	—

Courtesy National Carbon Div.



Carbon or graphite composition seal rings are used where there is relative motion in the presence of a gas or liquid that must be sealed out. (Stackpolé Carbon Co.)

advantages of carbon over other conducting materials is its resistance to corrosion by the active acid battery constituents. From a performance standpoint, the only possible substitute would be platinum. Carbon can be left porous to allow slow escape of the gases generated in the cell through the anode itself. Other rods are impregnated with wax or oil to prevent the evaporation of the electrolyte through the pores.

Electrical Contacts

Carbon and graphite are widely used in make-break electrical contacts. Typical applications are arcing tips, distributor buttons, and relay and contactor contacts. Combination materials containing silver, copper or cadmium are often used. The high softening point of carbon prevents it from freezing under high temperature arcing conditions. The graphite forms layers in the material structure and the graphite on top of each layer prevents sticking. These contacts also have inherent anti-arcing qualities, mainly due to the high vapor point of carbon—a higher potential is necessary to hold an arc between carbon contacts than between metal ones. Even with the same arcing conditions, less material is vaporized with carbon than with metal. While both carbon and graphite have higher specific resistance and contact resistance than any pure metals, their contact resistance does not increase with use. Metal contacts form oxide films, while carbon surfaces remain clean. These characteristics are imparted to combination metal-carbon contacts which contain only a small percentage of carbon.

Welding Carbons

Carbon welding rods hold advantages over metal rods in some applications. They give a more stable and a hotter arc than metal rods and generate a more inert atmosphere around the spot being welded. Their resistance to fusion is another big advantage. In operation, the arc is drawn between the carbon rod and the work. The weld metal rod is fed into the arc, where it is melted and deposited. Where the rod must carry high current densities, a graphite rod coated with copper is used.

Electronic Anodes

Graphite anodes are widely used in rectifier tubes, and in many cases they surpass molybdenum, tungsten and tantalum in power tube applications. Graphite is used for a number of reasons. It has the highest thermal emissivity of the small number of materials whose high temperature properties make them useful for electronic tube anodes. Graphite also has high heat conductivity. The graphite anodes thus increase the power dissipation, so that the temperature of associated tube elements is lower. Graphite does not develop hot spots and does not fuse under temporary overloads. The low thermal expansion of graphite also minimizes warpage and changes in the relative positions of tube components. The vapor pressure of the material itself is very low, even at high tube temperatures.

Anode graphite grades are high in

density and contain a minimum of impurities. Moreover, they are types that will machine readily, giving a hard surface. Anodes are machined rather than molded to shape. Some small anodes have walls as thin as 0.015 in., and shrinkage makes the required tolerances impossible to hold on molding.

Brushes

Brushes for rotating electrical machinery are almost invariably made of carbon, graphite or metal-graphite mixtures. The carbon brushes conduct electricity satisfactorily and run against iron, steel, copper or bronze without damaging the surface. In spite of their nonabrasive qualities, carbon brushes wear well themselves. Carbon brushes often travel half a million miles on commutator surfaces. The friction can be controlled, and the surfaces are not changed by arcing since carbon sublimates instead of melting.

There are a large number of grades and types of carbon brush materials. Each is designed for a particular type of service. Some brushes have low contact drop, others high. Low currents and high voltages require high contact drops. Some brushes are designed to have a slight polishing action on the metal commutator surfaces, while others do not. All these variations are made by controlling the ingredients and the manufacturing process. Metal powders and lubricant impregnants are added for special features.

Contact Shoes

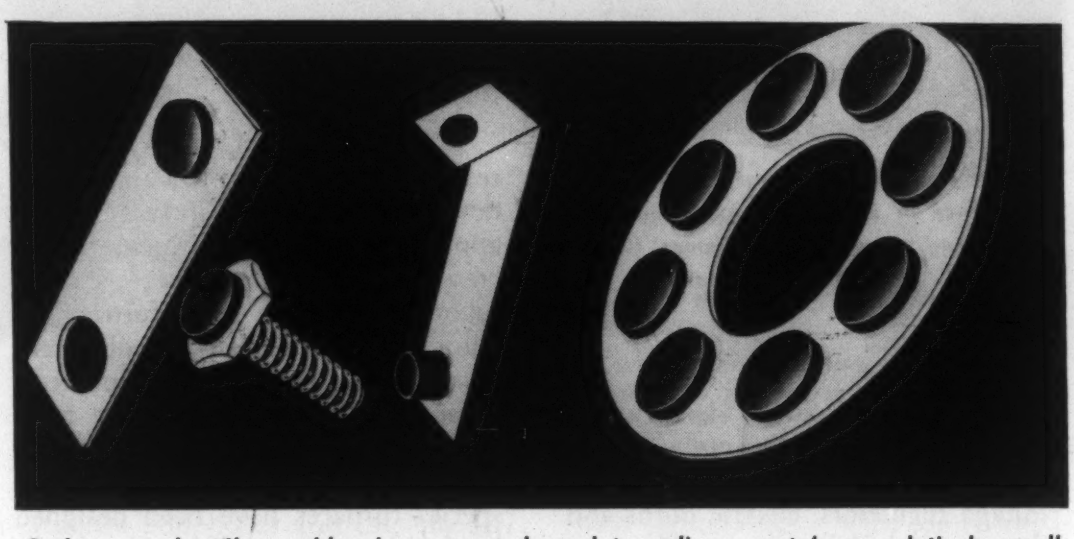
One of the most interesting uses of special carbon materials is in the overhead current collectors used on trolleys, trolley buses and electric railways. The conduction problem here between a stationary and a sliding contact is greatly complicated by weather and mechanical conditions. Water and ice on the wire tend to increase arcing, which, in turn, roughens the wire and increases the wear on the collectors. While it would be possible to make a shoe that would not wear, this would not answer the problem since such a shoe would only tend to wear down the wire. The best shoe, then, is a hard, strong, arc-resisting material that will last as long as possible in its own right but which will have enough lubrication to hold wire wear to a reasonable minimum. It is comparatively easy to change shoes on a trolley or on a locomotive, whereas renewing the overhead wire on an electrical system is a major repair job.

A major advantage of carbon shoes and collectors lies in the fact that radio interference is much less from them than from bronze or copper shoes. This is important now and will become even more important as the uses of television and FM expand.

Carbon Piles

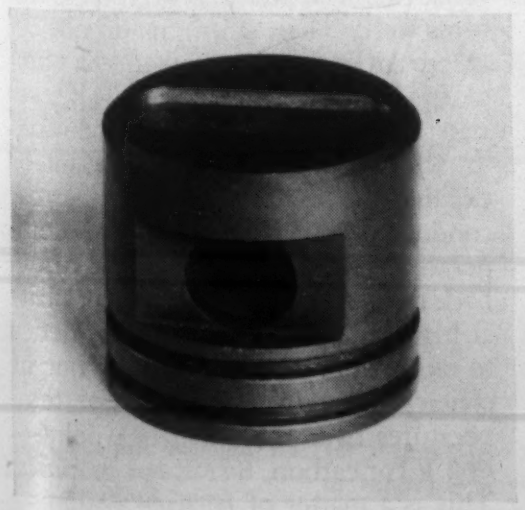
Many of the generator voltage regulators in use today employ a carbon pile or stack of carbon disks to control the field current. These same carbon disks are used as the pressure sensitive elements in a number of other resistance measuring devices. Typical applications are line regulators, speed regulators, pressure regulators, continuously variable rheostats and pressure indicators.

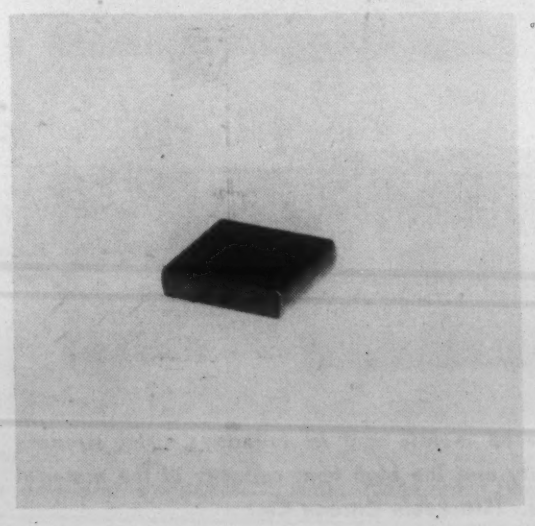
Carbon has various advantages over metals as the material for these regulator disks. Its specific resistance is high enough so that a reasonable size pile can be used to get resistance values high enough to control commercial currents and voltages. The surface of the carbon disks are also inert in air up to 250 F, and no deposits form on them to change resistance values. All metals that are commercially feasible would be afflicted by oxides or tarnish. Metals in disk piles could not reproduce results as carbon does, either.

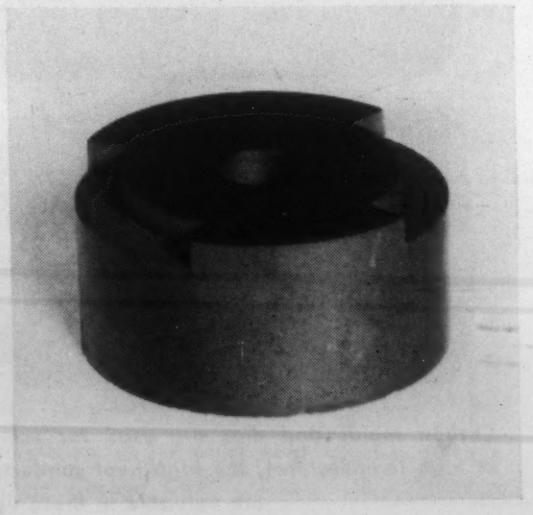


Carbon can be silver soldered or copper brazed to ordinary metals on relatively small surfaces. If the part dimensions are over 3/8 in., carbon can be soldered to metals with the same coefficient of expansion as the carbon. (Stackpole Carbon Co.)

Pump vanes, pistons and thrust plates are other applications. (Pure Carbon Co., Inc.)







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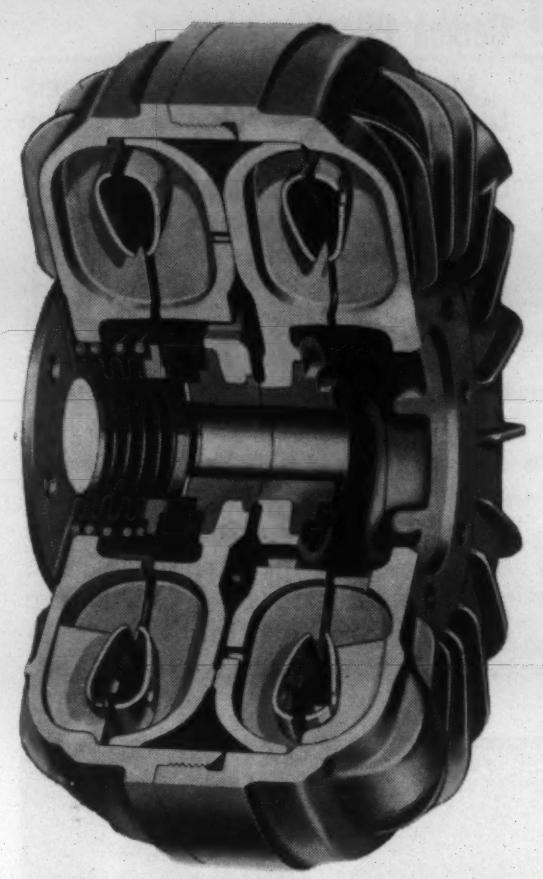


Carbon-graphite seals have found wide acceptance in fluid couplings, torque convertors and hydraulic transmissions. (United States Graphite Co.)

Resistors

Carbon composition electrical resistors are used as lightning arrestors, surge resistors, ignition resistors, low-voltage regulators, electric horns and electric windshield wipers. These resistors have a conductor material of high specific resistance mixed with a filler and binder. Carbon is the most common conducting material; silica, talc, clay, rubber and phenolics are used as binders and fillers. A mixture of the proper proportions for the particular application is put into an insulating container or baked onto a glass rod and sealed in a container. These resistors are cheap, compact and effective for low voltages, and are particularly widely used in electronic apparatus. Wire wound resistors of equivalent characteristics for radio work would be more expensive and bulky. The composition of these resistors can be chosen to give a low temperature coefficient of resistance. This coefficient can be changed by varying the amount of carbon, which, unlike other resistance materials, decreases in electrical resistivity with rising temperatures.

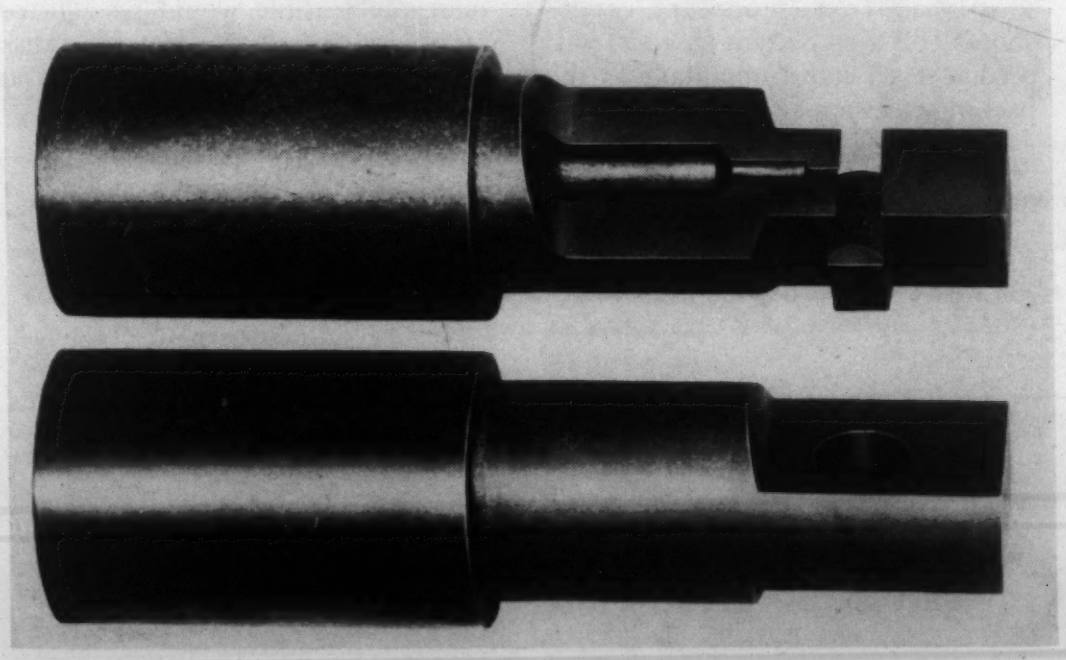
Heating Elements

Many special carbon and graphite resistance heating elements have been developed for electric furnaces. The application of these elements is increasing, especially where carbon tubes are used as both furnace resistor and muffle. Because of a tendency to oxidize at relatively low temperatures, carbon and graphite must be protected from air. This is not too insuperable a problem, however, and special furnaces have been designed to give the necessary protection. Carbon and graphite have a number of compensating advantages. The high softening points of these materials give them a wider temperature range than any other common resistance material, with commercial applications up to 6000 F. Both materials can also take drastic thermal shocks without damage. Carbon resistance materials are available in rod, slab, tube and other shapes.

Welding and Brazing Tips

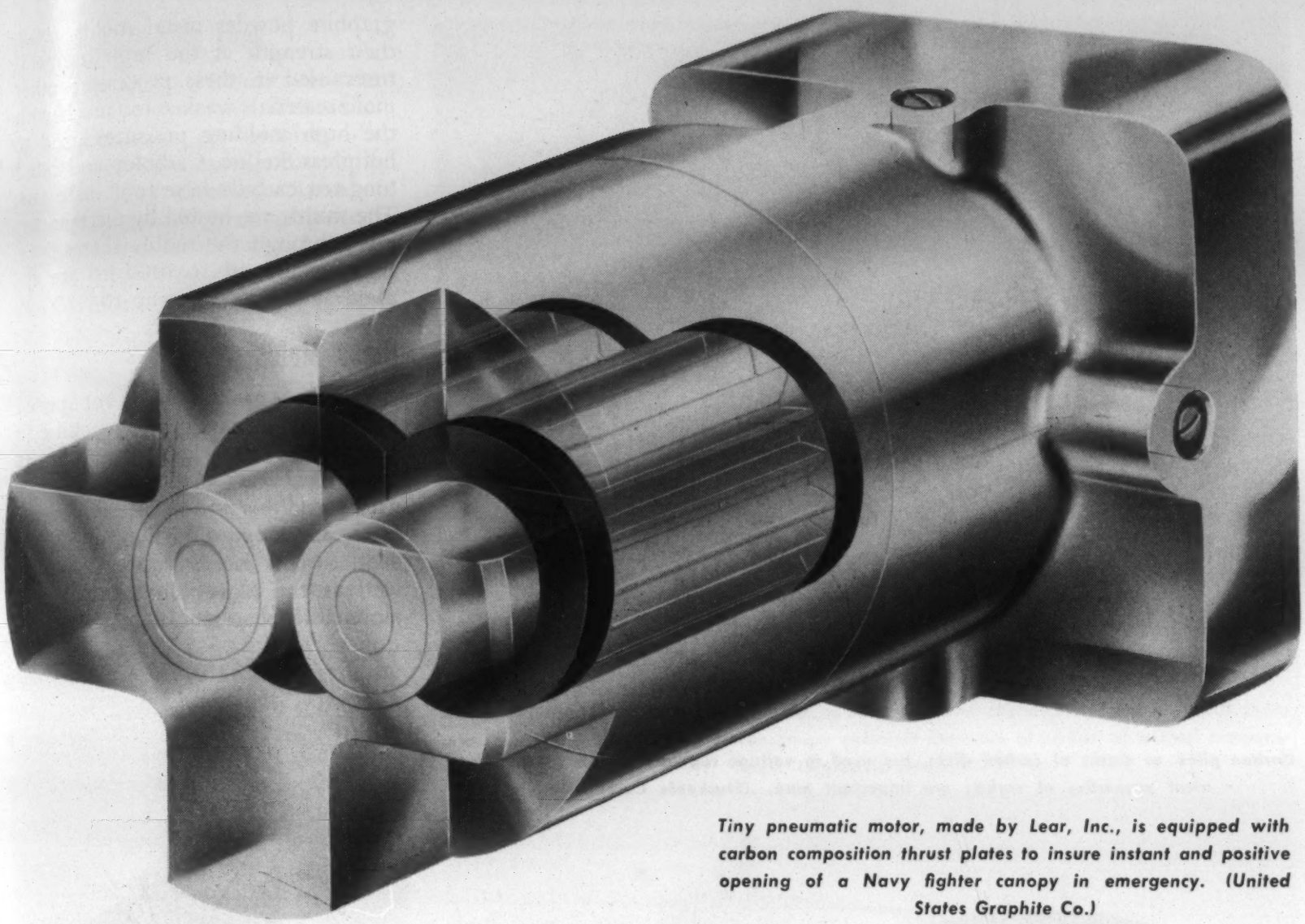
Carbon and graphite materials are used in tips for resistance welding and brazing. These tips are not used on resistance welding where currents and pressures are high and the material joined does not reach the melting temperature. Their big application is in incandescent carbon brazing, where the heat is conducted between the tips to melt either one component in the joint or solder introduced between. The advantage of carbon here is that its high softening point prevents it from sticking to the work or mushrooming under the heat and pressure. Carbon is also easy to form in the odd shapes required in these tips; and its resistance to thermal shock allows radical temperature changes. Carbon is not strong enough to take the pressures used in conventional resistance or spot welding, however. Its tendency to oxidize at brazing temperatures would seem to be a disadvantage, but special treatments have been perfected which greatly increase the oxidation resistance of carbon and graphite tips and give them long service life.

Refractory Applications



Carbon molds and dies are used for powdered metals and in foundries. The strength at high temperatures, the high heat conductivity and the high heat capacity of the material are valuable in these uses. (Stackpole Carbon Co.)

Carbon and graphite are outstanding refractory materials. Both have extremely high softening points and resist chemical attack at high temperatures well. Their strengths do not decrease at the temperatures met in commercial heating applications. They resist thermal shock and have an unusually low temperature coefficient of expansion. In addition, their thermal conductivities decrease as the temperature increases. The only drawback to the use of carbon and graphite at high temperatures is their tendency to oxidize. They must be kept out of contact with air and oxygen at temperatures over the oxidizing point—662 F for carbon, 842 F for graphite. This is a matter of furnace design.



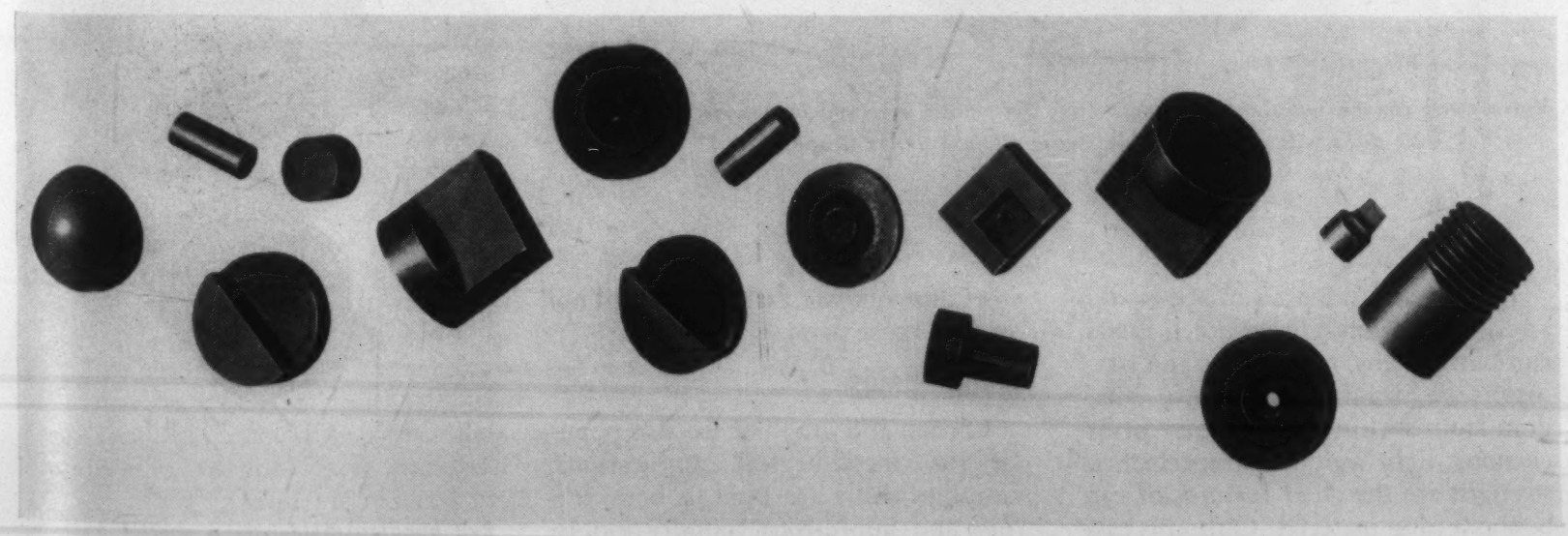
Tiny pneumatic motor, made by Lear, Inc., is equipped with carbon composition thrust plates to insure instant and positive opening of a Navy fighter canopy in emergency. (United States Graphite Co.)

Refractory Linings

The newest, and one of the most important refractory applications of carbon and graphite materials is in blast furnace linings. This was common practice in Germany before the war, and really caught on in this country in 1945. About 25% of American blast furnaces are now partially carbon lined.

Carbon is also used to line ferro-alloy furnaces and furnaces used to produce phophorus and calcium carbide. It is the only lining material that will withstand 3600 F in the carbothermic process for making magnesium. It is also used in making beryllium oxide and beryllium copper, where temperatures up to 3600 F are common. In the production of aluminum, about 7½ lb of carbon lining are required for every 100 lb of aluminum produced.

Furnace linings are usually made with carbon blocks, with joints filled with carbon paste. The paste joints bake into solid carbon when the furnace heats up. The blocks can also be machined to fit up into close joints. In complicated linings, where a good deal of machining is required to fit up the lining, graphite is sometimes preferred to carbon as a lining material in spite of the higher cost and heat conductivity of graphite.



Carbon and graphite tips for incandescent carbon brazing do not stick to the material or mushroom under white heat. Carbon is easy to fabricate in the odd and complicated shapes required. (Stackpole Carbon Co.)

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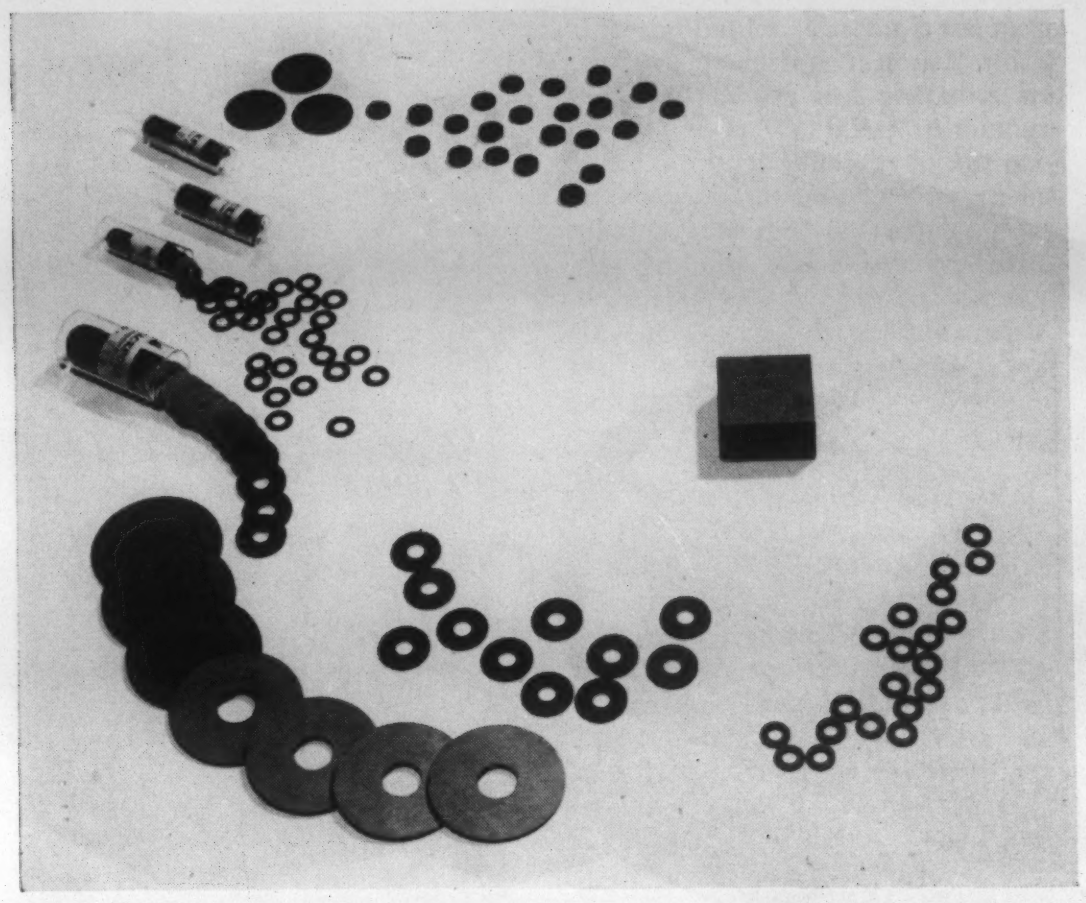
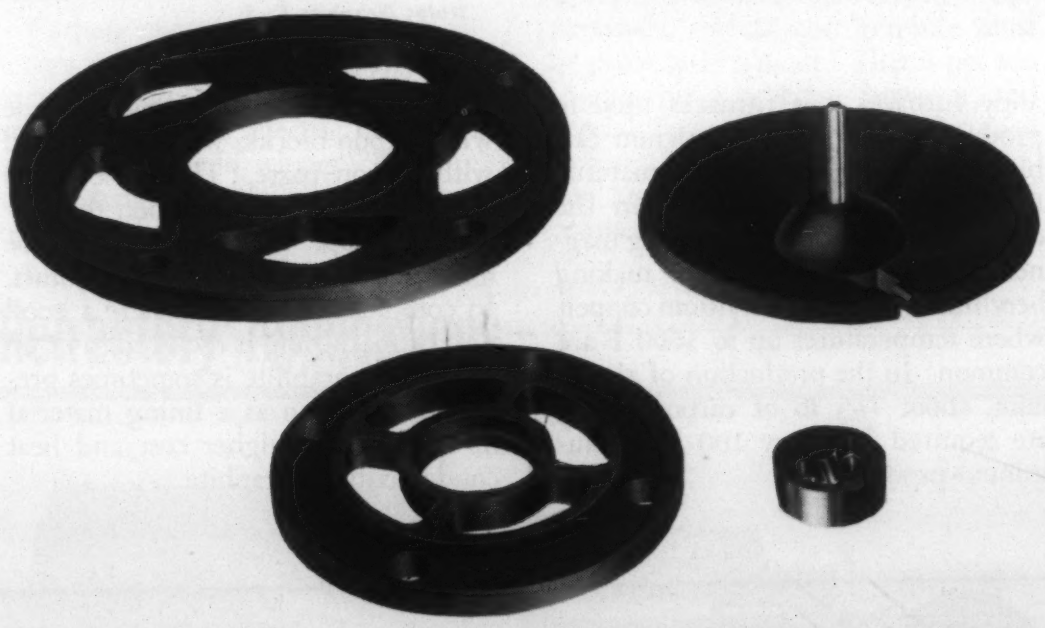


Carbon piles, or stacks of carbon disks, are used in voltage regulators. The special electrical properties of carbon are important here. (Stackpole Carbon Co.)



Valve parts can be machined to close limits. Since they are light in weight, carbon valve disks will record small volumes. (United States Graphite Co.)

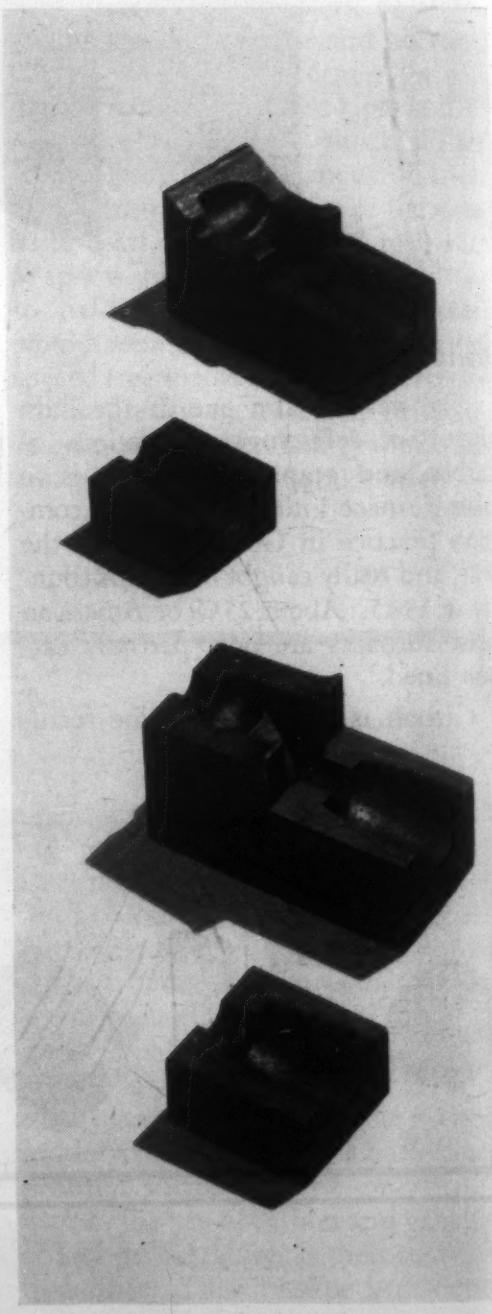
In addition to blast furnace linings and wall sections, cinder notch liners, run-out troughs, mold plugs and stool inserts are also made of carbon. Freedom from sticking, the absence of inclusions, light weight and mechanical strength are the chief features of carbon as a plug material. Carbon is easy to fabricate in the shapes required for both plugs and stool inserts. Hot steel does not wet carbon and will not stick to these parts.

Metal Molds

Carbon and graphite are also popular in metallurgical applications. Graphite chills are used in both ferrous and nonferrous foundry molds, because of the high heat capacity and conductivity of graphite. Carbon and graphite powder metal molds retain their strength at the high temperatures used in these processes; other mold materials weaken too much with the high molding pressures used to hot-press Stellite, Carboloy and other tungsten carbide base tool materials. The molds are heated by electric currents through the molds themselves, and pressures up to 1000 psi are applied at temperatures up to 2200 F.

Glass Molds

Carbon is used in molds for special glass shapes. It is easy to machine to any desired shape, making it more economical on small special runs where mold cost is an important factor. On long production runs, however, carbon molds do not wear as well as the more conventional and more costly steel molds.



Rail bonding molds are a special application of carbon. The molten metal is held to make the joint. (Stackpole Carbon Co.)

Continuous Casting Dies

Some of the continuous casting machines use graphite molds. The molten metal runs into the graphite die, where it is cooled enough to solidify before being withdrawn from the bottom. The advantage of graphite is that the metal does not stick to the die. The graphite also has enough heat conductivity to cool the metal rapidly.

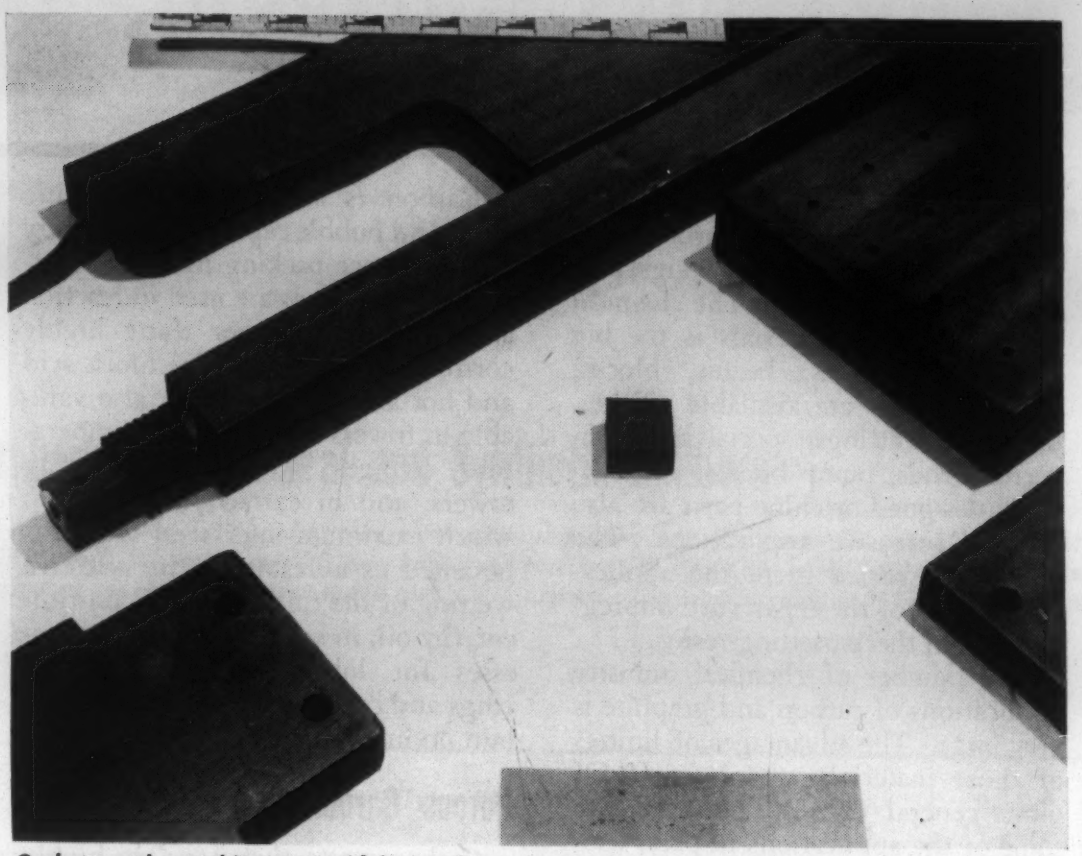
Rail Bonding Molds

A comparatively recent development using graphite molds is the application of thermite to weld the copper cables which run around the joints in railroad and traction line rails. The rail joints are shunted with copper cables so that they will serve as dependable conductors under all conditions. These cables are quickly and economically welded to the rails by means of graphite molds. Graphite is suitable for these molds because the metal will not stick to it. It also stands the thermal shock of the thermite reaction well. A single mold will make several hundred joints before becoming worn.

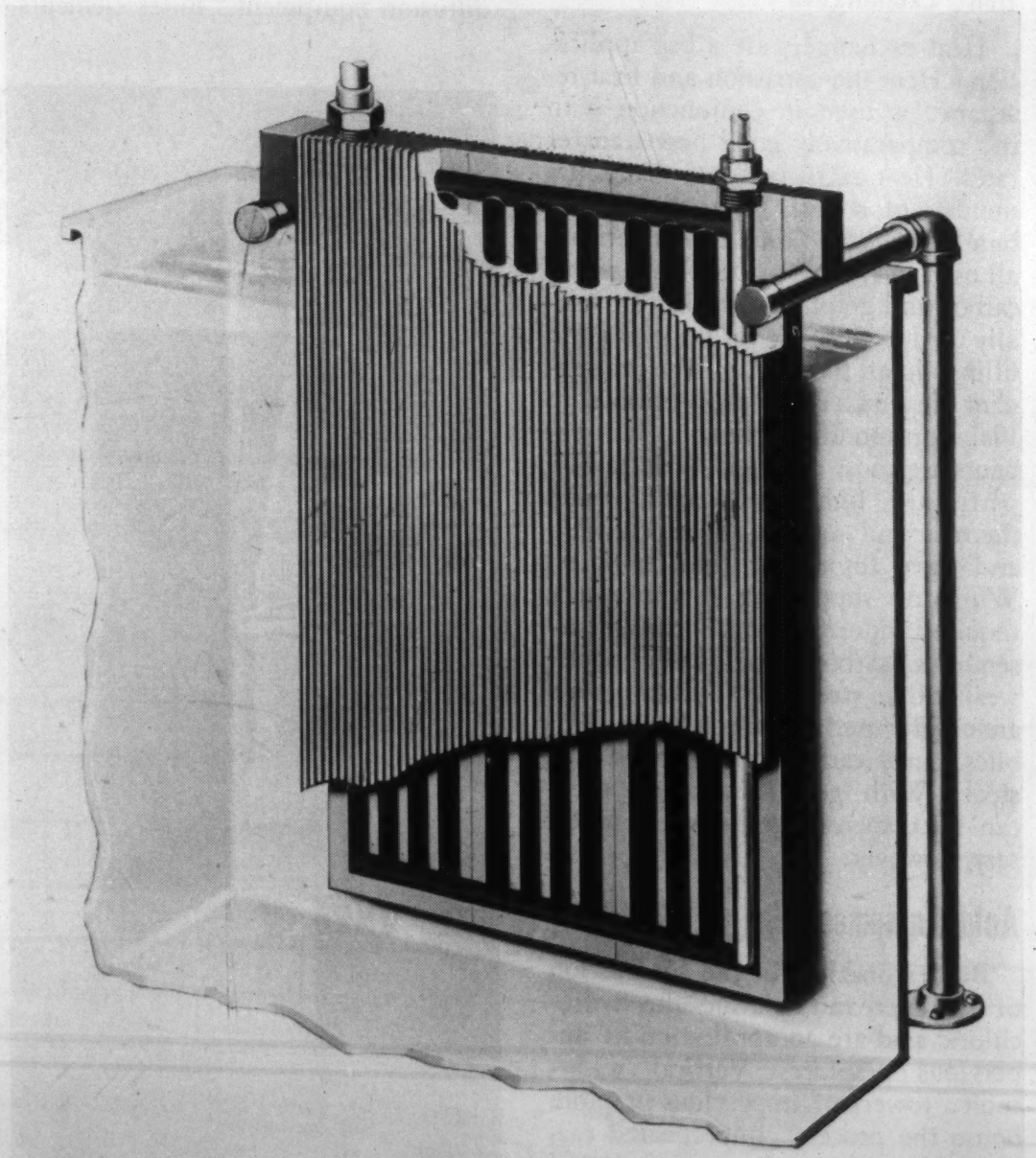
Furnace Boats

The use of furnace brazing for assembled parts is increasing. Each part that goes through a brazing furnace must be supported so that the brazing alloy will flow correctly and parts will not move with respect to each other before the brazing material solidifies. The characteristics of carbon make it economical for high production items involving small parts. In the first place, carbon is readily machined into the complicated shapes that are so often required. Alloys will not stick to carbon, nor will copper and the silver solders wet it, so that there is no danger of parts being brazed to their supports. Carbon can also stand severe thermal shocks without spalling or cracking, so that parts can be cooled very quickly after the braze is completed.

Various other types of trays are used to pass materials through high temperature furnaces. These trays can be used to temperatures well beyond those which any other refractory material will stand and with almost indefinite life, providing only that oxidizing conditions are avoided. Tungsten, for example, is reduced in graphite trays. In general, any place a container is exposed to temperatures over 1800 F, graphite is a good bet.



Carbon and graphite are widely used in structural and chemical applications. All these uses take advantage of the extraordinary chemical inertness of carbon at normal temperatures. (Stackpole Carbon Co.)



Carbon material plate heaters are designed for service where heating or cooling of corrosive liquids is required. (National Carbon Div.)

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Chemical Applications

The chemical process industries use molded and extruded carbon and graphite products in wall facings, piping and machine parts. The chemical inertness of the materials is the big advantage. Bricks, beams, blocks, plates and tiles are available. Tubes, pipes, pipe fittings, special pipe connectors, rods, pump bodies, and specially designed machine parts are also used in corrosive applications. The porosity is varied to fit the application. Many of these parts are impregnated with thermosetting resins.

The number of chemical industry applications of carbon and graphite is very large. The advantages of linings of those materials are obvious. Of more general interest, however, are some of the applications in parts usually made of metal.

Heat Exchangers

Heat exchangers are a big application. Here the corrosion and heat resistance is used in conjunction with the comparatively good heat transfer rates. Heat exchangers are made in a number of styles. Bayonet, cascade, bundle, shell and tube exchangers are all used in various places. Impervious carbon and graphite materials are usually used exclusively for the pipes and fillings in all these units. The impregnant depends upon the application. Plain or modified phenolic impregnants are most common. The carbon parts are light in weight, resist thermal and mechanical shock well, and have high heat transfer rates. While no supporting structures are required for carbon heat exchanger assemblies, carbon pipe is still much weaker than steel pipe. Flexible joints are usually used on carbon pipe assemblies, since carbon cannot bend like steel. With good alignment, these can be dispensed with when necessary, however.

Acid Equipment

Burner nozzles for the combustion of hydrogen and chlorine into hydrochloric acid are an application of impervious graphite. Vertical water-cooled towers of impervious graphite house the process. Impregnated carbon and graphite towers are also used in hydrochloric acid absorbers, where the gas and water are mixed, and in sulfuric acid diluting equipment.

Carbon is also used for Raschig rings and bubble caps, giving industry a good tower packing material. Carbon Raschig rings are used in reaction and scrubbing towers using highly corrosive agents like hydrochloric acid and hot alkalies. They are also valuable in towers where sudden temperature changes occur, in rectifying towers, and in extraction systems in which maximum interfacial surface is obtained as a result of the selective wetting of the carbon by one constituent (by oil, in solvent extraction processes for lubricating oils). These rings and caps are all carbon and contain no impregnating material.

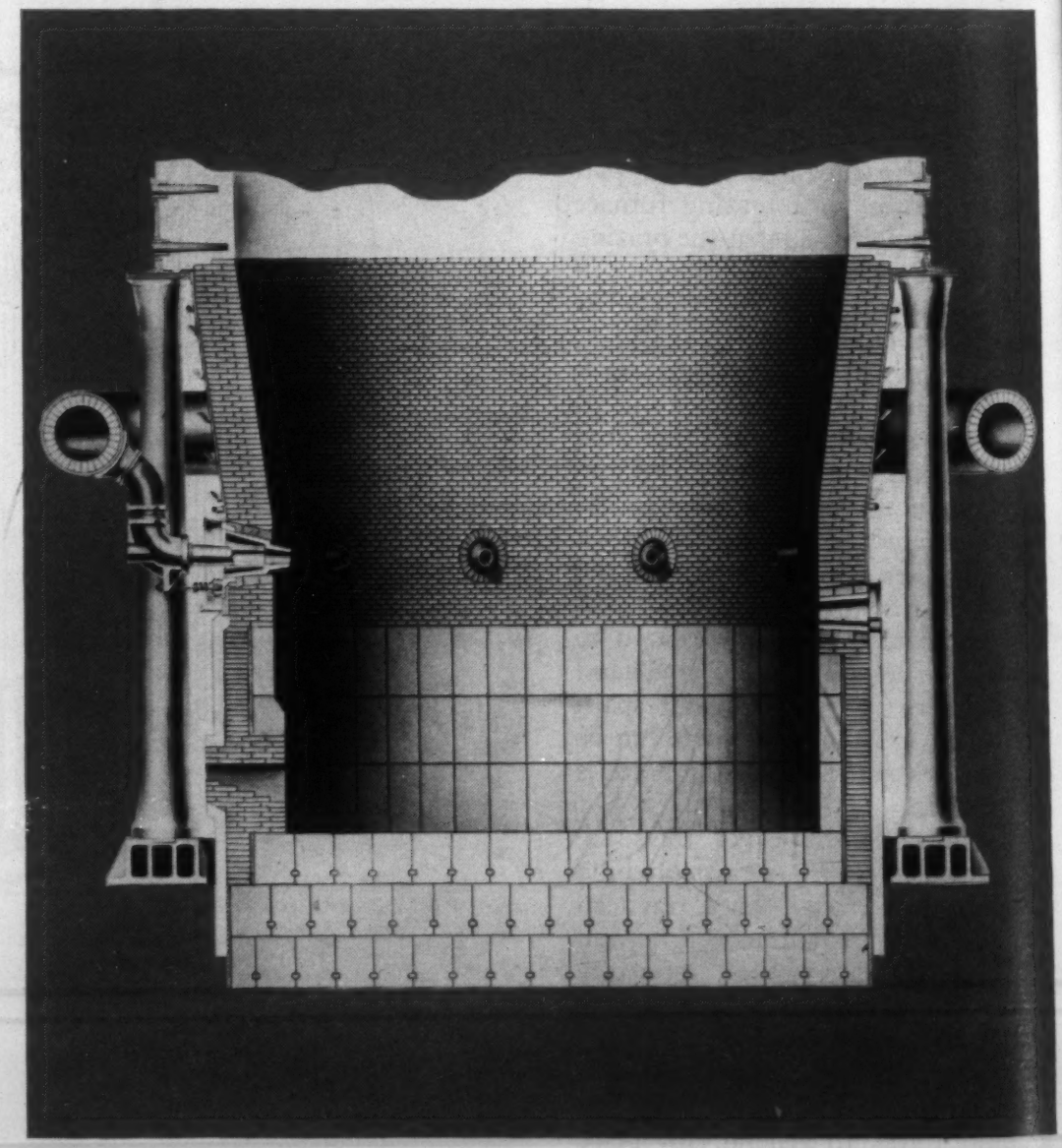
Porous Carbon

Carbon parts that are left highly porous in manufacture have special applications in filtering, aerating and diffusion equipment. Filter elements are made in the form of tubes, plates and disks, and are used with steam, molten metals and molten salts. Porous carbon is a rigid filtering agent that gives a positive filtering action. It is also made into diffuser pipe, used to bubble gases through liquids. The porosity of these diffusers can be controlled to give any rate of bubbling wanted.

Acknowledgment

We wish to acknowledge the help we have received from the publications and personnel of the following organizations:

The Carbone Corp.
Graphite Metallizing Corp.
Morganite Inc.
National Carbon Div., Union Carbide and Carbon Corp.
Pure Carbon Co., Inc.
Speer Carbon Co.
Stackpole Carbon Co.
The United States Graphite Co.



Carbon linings are used for the hearth and wall sections of blast furnaces. Run-out troughs are also lined with carbon. (National Carbon Div.)

Materials Engineering File Facts

NUMBER 225
April 1952

MATERIAL:
Rubber

Relative Properties of Natural and Synthetic Rubbers

The designations of the synthetic rubbers are derived from the part played by the Government in their production. The symbol GR means "Government Rubber." Uses include automobile tire casings (GR-S); rolls for printing textiles, hose, belting and packing (GR-A); oil or gas seals and resilient parts in silent electrical discharge apparatus (GR-M); diaphragms and inner tubes for automobile tires (GR-I); solvent resistant applications in contact with petroleum products and other organic solvents (GR-P).

Property	Natural Rubber	Buna S Type GR-S	Buna N Type GR-A	Neoprene GR-M	Butyl GRI	Thiokol GR-P
Tensile Strength	E	G	G	G	G	F
Elongation	E	G	G	E	E	G
Resilience	E	G	G	G	P	G
Electrical Properties	E	E	F	F	E	F
Impermeability to Gases	G	G	G	VG	E	E
Impermeability to Water	G	FG	FG	FG	FG	VG
Resistance to Plastic Flow	VG	G	G	G	FG	P
Resistance to Abrasion	VG	VG	VG	VG	F	P
Resistance to Tear	VG	FG	FG	G	F	VG
Resistance to Heat	G	VG	VG	VG	F	P
Resistance to Cold	VG	VG	VG	G	G	VG
Resistance to Air	F	G	G	E	E	E
Resistance to Ozone	P	P	F	E	E	E
Resistance to Light	F	F	P	E	E	E
Resistance to Petroleum	P	P	E	G	P	E
Resistance to Solvents	P	P	F	F	P	E
Resistance to Cyclic and Chlorinated Hydrocarbons (Benzene, Toluene, Xylene, Carbon Tetrachloride, Chloroform, Etc.	P	P	F	P	P	G
Resistance to Strong Oxidizing Agents	P	P	P	P	G	P
Resistance to Other Corrosives	G	G	G	G	G	G
Resistance to Aging	G	E	E	E	E	E
Resistance to Flame	P	P	P	G	P	P
Resistance to Abrasion (Soaked in Oil)	P	P	E	F	P	P
Resistance to Paint and Ink Dryers	P	G	E	E	E	E
Resistance to Swelling in Lubricating Oil	P	P	E	G	P	E
Resistance to Deterioration in Oil	P	G	E	E	G	F
Vulcanizing Properties	E	E	E	E	F	F
Adhesion to Metals	E	E	E	E	—	P
Adhesion to Fabrics	E	F	G	E	G	F
Adaptability for Contact with Foods*	E	—	F	F	G	P
Color Range	G	G	F	G	G	P
Freedom from Odor*	G	F	F	F	G	P
Workability	E	F	G	G	G	F
Approximate Specific Gravity Basic Material	0.93	0.94	1.00	1.25	0.90	1.35
Hardness Durometer A Tests (100 Is Bone Hard)	20 to 100	35 to 100	20 to 100	20 to 90	15 to 75	25 to 80

* *These properties available only in specific compounds.*

E = Excellent
VG = Very good
G = Good
FG = Fair to good
GE = Good to excellent
F = Fair
P = Poor

From "Extrusion of Plastics, Rubber and Metals" by Herbert R. Simonds, Archie J. Weith and William Schack, published by Reinhold Publishing Corp.

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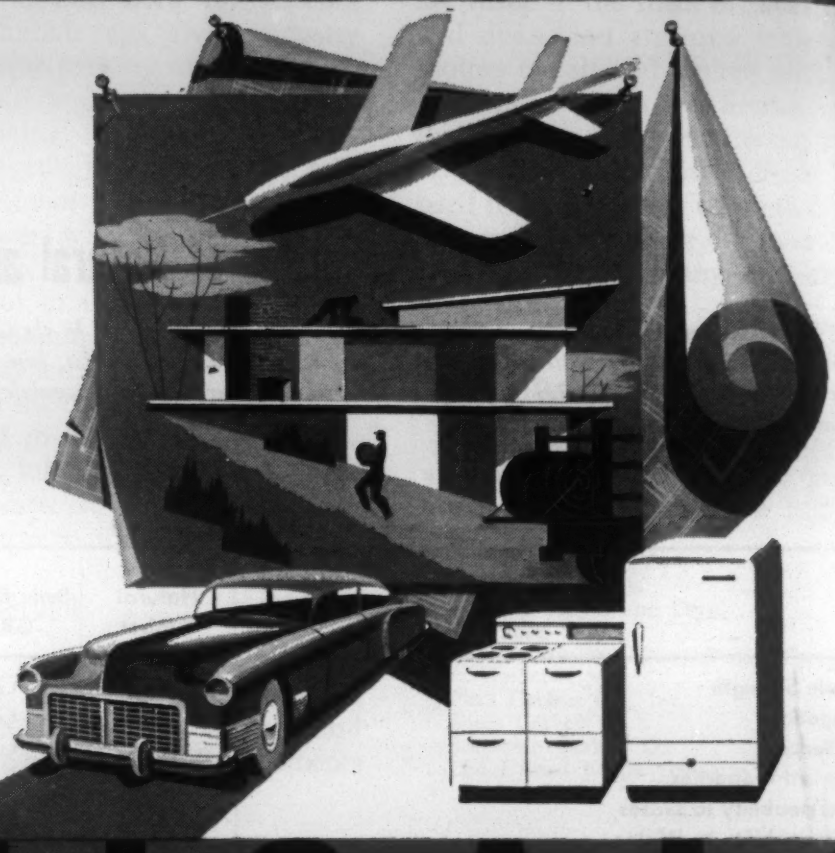

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Materials Engineering File Facts

NUMBER 226
April 1952

Materials Data Sheet

Chromium-Vanadium Steels

These steels are included in the AISI list of standard steels. They are used particularly in automotive and aircraft engine applications and as springs. The properties given below were determined on small parts. Chromium-vanadium steels are used frequently for parts of large size, and the properties of such parts may be different from those given.

AISI Type	6120	6145	6150	6152
COMPOSITION, %	C, 0.17/0.22 Mn, 0.70/0.90 Si, 0.20/0.35 Cr, 0.70/0.90 V, 0.10 min	C, 0.43/0.48 Mn, 0.70/0.90 Si, 0.20/0.35 Cr, 0.80/1.10 V, 0.15 min	C, 0.48/0.53 Mn, 0.70/0.90 Si, 0.20/0.35 Cr, 0.80/1.10 V, 0.15 min	C, 0.48/0.53 Mn, 0.70/0.90 Si, 0.20/0.35 Cr, 0.80/1.10 V, 0.10 min
PHYSICAL PROPERTIES				
Density, Lb/Cu In.	0.283	0.283	0.283	0.283
Thermal Cond, Btu/Hr/Sq Ft/Ft/F, @ 212 F	27	27	27	27
Coeff of Exp per F:				
70–1200	8.1×10^{-6}	8.1×10^{-6}	8.1×10^{-6}	8.1×10^{-6}
Spec Ht, Btu/Lb/F:	0.10–0.11	0.10–0.11	0.10–0.11	0.10–0.11
Elect Res, Microhm-Cm @ 68 F:	21	21	21	21
Magnetic Properties	Magnetic	Magnetic	Magnetic	Magnetic
MECHANICAL PROPERTIES				
Mod of Elast in Tension, Psi	$29–30 \times 10^{-6}$	$29–30 \times 10^{-6}$	$29–30 \times 10^{-6}$	$29–30 \times 10^{-6}$
Tensile Str, 1000 Psi:				
Normalized 1600 to 1650 F	85	115	158	...
Hard and Tempered (see notes)	105 (a) 125 (b)	176 (c) 136 (d)	187 (c) 144 (d)	151 (e) ...
Yield Str, 1000 Psi:				
Normalized	50	75	88	...
Hard and Tempered	71 94	169 130	179 138	125 ...
Elong in 2 In., %:				
Normalized	35	24	23	...
Hard and Tempered	19 21	16 22	13 18	16 ...
Reduction of Area, %:				
Normalized	67	64	62	...
Hard and Tempered	37 56	52 58	42 53	54 ...
Hardness Bhn:				
Normalized	185	216	240	...
Hard and Tempered	... ...	429 311	444 363	... ...
Impact Strength, Izod, Ft-Lb:				
Normalized	102	31	...	...
Hard and Tempered	25 28	20 87	13 63	... ...
Fatigue Strength	Fatigue properties are proportional to the tensile strength in the same ratio as other low alloy steels. At values of hardness below 400 Brinell, the ratio is about 50%, and at higher hardnesses it is 45 to 48% of the tensile strength.			
THERMAL TREATMENT				
Normalizing Temp, F	1650/1700	1600/1650	1600/1650	1600/1650
Hardening Temp, F	1600/1650	1550/1650	1550/1650	1550/1650
Tempering Temp, F	375/1200	450/1200	450/1200	450/1200
FABRICATING PROPERTIES				
Formability	Similar to those of other alloy steels of low chromium content. The hot working temperatures are not limited by brittle ranges but by the degree of malleability required for the specific application. Because of the stiffening effect of the alloys, cold-working is somewhat more difficult than with carbon steels.			
Machinability Index (B1112 steel = 100)				
Hot-rolled	27	22	24	24
Normalized	46	27	26	26
Weldability	These steels are weldable by all of the commercial welding procedures, the difficulty of welding increasing with the carbon content. Preheating and postheating treatments are sometimes necessary.			
CORROSION RESISTANCE	The corrosion resistance of the chromium-vanadium steels is similar to that of the carbon steels. The chromium content is too low to have any appreciable influence on the rate of corrosion.			
AVAILABLE FORMS	These steels are available in all standard mill forms.			
USES	Carburized gears, shafts, piston pins, bushings. Also for nitrided and carbonitrided parts.	Crankshafts, connecting rods, bevel and spur gears, shafts, springs, axles, pins		

NOTES: *a—Typical core properties; carburized at 1680 F for 16 hrs, pot cooled, oil-quenched from 1425 F, tempered at 300 F.*
b—Typical core properties; carburized at 1680 F for 16 hr, pot cooled, oil-quenched from 1525 F, tempered at 300 F.
c—Normalized at 1600 F, oil-quenched from 1575 F, tempered at 1000 F.
d—Normalized at 1600 F, oil-quenched from 1575 F, tempered at 1200 F.
e—Oil-quenched from 1575 F, tempered at 1000 F.

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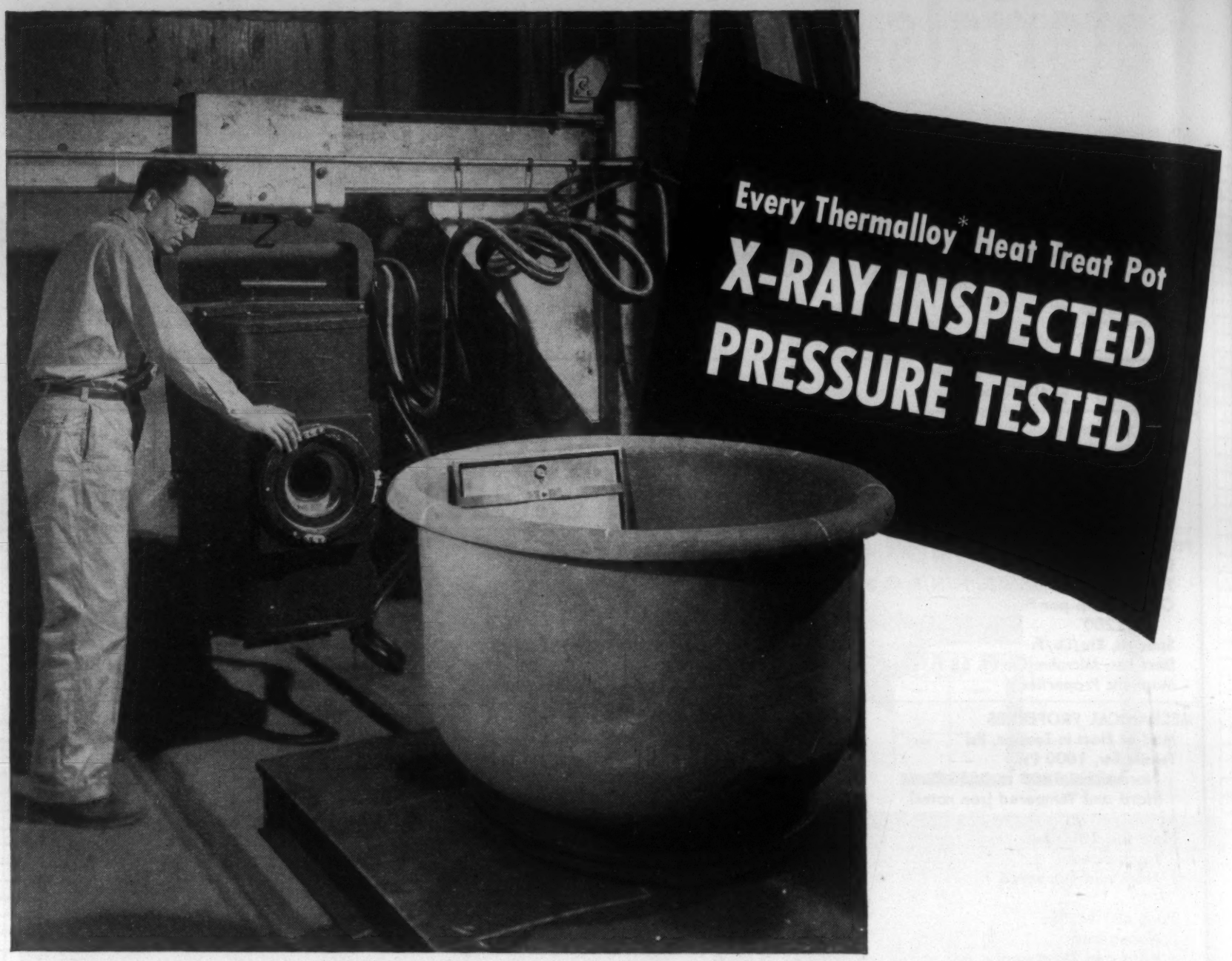

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- With a competitive alloy, customer was receiving 1,500 to 3,500 hours service. On switching to Thermalloy pots, service life jumped to 3,800-5,550 hours in identical service.

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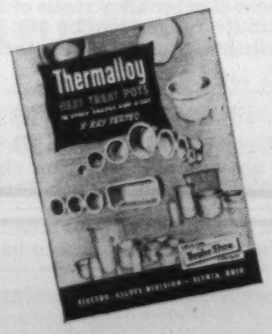
This careful inspection, plus Thermalloy's outstanding heat-resistant properties, are your guarantee of top quality. Why not make Thermalloy your standard in buying heat treat pots?



Over 100 sizes in both round and rectangular pots are available for production from stock patterns. Write for Bulletin T-205, listing shapes and sizes available. Electro-Alloys Division, 2084 Taylor St., Elyria, Ohio.

Specify THERMALLOY* for heat and abrasion resistance... CHEMALLOY* for corrosion resistance

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AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION
ELYRIA, OHIO

New Materials and Equipment

Vinyl Dispersions Provide Chemical Resistance, Durability, Flexibility

After five years of research in vinyl plastics and their application to manufactured products in nearly every type of light industry, *The Watson-Standard Co.*, Pittsburgh 30, has announced five basic products that are currently available. These vinyl plastics, referred to technically as dispersions, are: Organosol, Plastisol, Foamosol, Rigidsol and Plastigel.

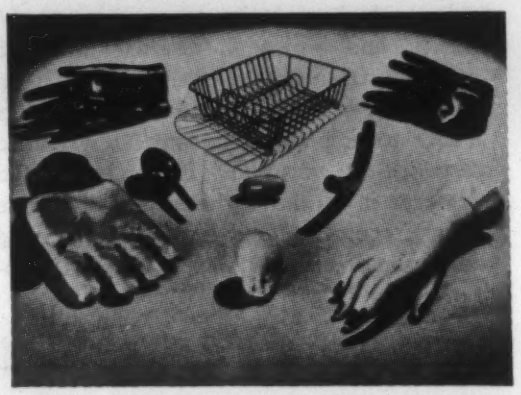
The products are primarily designed to apply to different types of molding, making it possible to produce finished items with accent on chemical resistance, durability and a wide range of flexibility. The outcome has resulted in eliminating many deficiencies of rubber, including solvent resistance and the addition of color. The great range of colors and shades and their extreme chemical resistance are unusual factors that make these vinyl products particularly outstanding. Although each dispersion has specific types of application, their overall features include simplicity of manufacturing processes, thus reducing costs and increasing availability and application, and the conservation of vital metal and rubber stockpiles so necessary for the defense effort.

These plastics can be fabricated without use of high pressure, thus effecting extensive savings in the cost operation. Since the price of the raw output is nominal, they can compete with other plastics on the market. The first of the vinyls, Organosol, is basically used for film coating. The second, Plastisol, is much more varied for use, but at the same time should not be confused with Organosol, which contains volatile solvents. It is 100% total solid materials with appropriate stabilizers, pigments and other modifiers added. Plastisol products include doll parts, play balls, small squeezable bottles, unsupported gloves, and coverings for small hand tools and other metal objects. Also, as a replacement for rubber, Plastisol is said to have been coated on the bumpers of metal shopping baskets, and tests proved that the plastics did not crack or tear as did the rubber. Plastisol also has been used successfully as a coating for automatic light sockets to seal out dust and moisture.

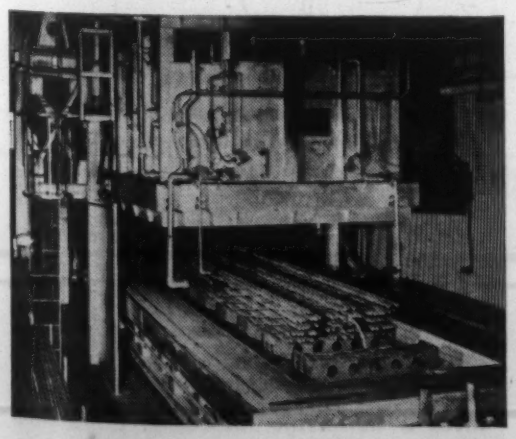
Foamosol has the appearance and physical properties of foam rubber, and, of course, can be manufactured in a wide variety of colors. Because of possible cutbacks as a result of materials shortages, this plastic may be the answer to the manufacturers of bedding, furniture, floor padding, upholstery, clothing and shoes.

Rigidsol, primarily used for molding and casting, combines properties of toughness and apparent rigidity and is, at the same time, pliable. Like Plastisol and Foamosol, it offers many uses for industrial applications, including gaskets, tubing, hose and flexible bottles. It is reported that Rigidsol piping is now being used in the oil fields of the Southwest on a limited scale.

The fifth vinyl plastic, Plastigel, is designed for casting and extrusion. According to the company, it can be pre-formed or pre-shaped and then cured as against the conventional vinyl dispersion which must be cured in the mold.



These Plastisol products offer the durability and chemical resistance attributed to the new vinyl dispersions.



Here, a charge of bars are moving into place beneath the cover of the new controlled atmosphere furnace.

Controlled Atmosphere Furnace for Carbon Restoration

A new controlled atmosphere furnace, developed by *Surface Combustion Corp.*, Toledo, is currently being used at the Hazelwood Cold Finishing Dept., Jones & Laughlin Steel Corp., Pittsburgh, to supply carbon-restored bars. The furnace is said to make possible the attainment of heat treated hardness at the surface without the necessity of removing a decarburized skin. The first of its kind to be designed specifically for carbon restoration, the new unit will also perform other thermal treatments, such as annealing, bright annealing, spheroidizing and normalizing.

As steel passes through the various shaping processes, from ingot to bar, it is alternately heated and cooled successively. This tends to deplete the carbon from the skin of the bar, leaving it decarburized. The fabricator who wants a bar with enough surface hardness to resist wear and abrasion would have to machine or grind such a decarburized bar, prior to heat treating, to remove the soft, unhardenable skin. But with the new process this surface metal removal is not required, as sufficient metal is said to be restored to the surface to insure that the desired surface hardness will be obtained in heat treating.

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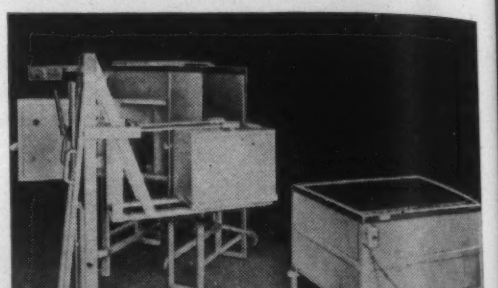
New Materials and Equipment continued

Parts Heat Treated in Cartridge Containing Atmosphere

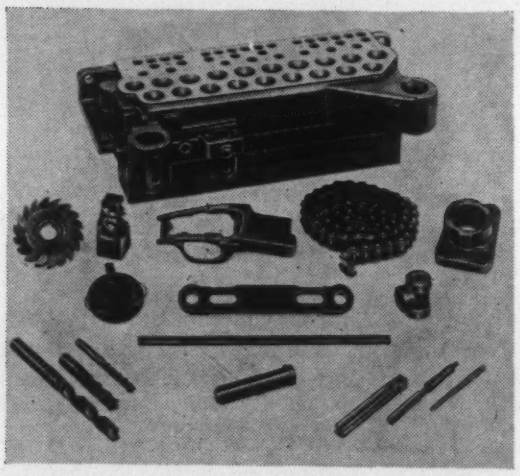
A simple and practical method of blanketing metals with hydrogen, nitrogen, carburizing or other atmospheres while they are being heat treated in the smaller shop type furnace has been developed by *A. D. Alpine, Inc.*, 11837 Teale St., Culver City, Calif. The method employs a cartridge which contains the parts to be treated and which is inserted into and removed from the Alpine Contro-Therm furnace by a mechanical loader truck. This loader truck picks up a completely loaded cartridge at any point in the shop and deposits it in the furnace. The cartridge is then connected to a tank of the desired atmosphere and charged. Pressured, protective atmosphere is then maintained within the cartridge during the heating cycle.

The cartridge is said to be so carefully engineered that the charging and maintenance of the protective atmospheres of an entire cartridge load of work costs only a few cents per heat. When the heat treating cycle is completed, the mechanical loader is again employed to remove the entire cartridge load and to quench the work, whether in air or in a liquid.

According to the company, the entire operation can be performed successfully by a novice using the visual instrumentation which comes as standard equipment.



The Alpine cartridge is shown on the fork lift loader as the treated work is about to be deposited in the quench tank.



These parts have been blackened with the Nu-Black method, which is effective over a wide temperature range.

Blackening Bath for Ferrous Alloys Effective over Wide Temperature Range

A new, two-bath method for blackening all ferrous alloys, malleable and cast iron, and carbon steels has been perfected by *Swift Industrial Chemical Co.*, Canton, Conn. Nu-Black, as the method is called, is said to be effective over a wide temperature range creating a black surface of uniform density without bringing about any dimensional change in the piece so blackened.

The method's operational efficiency is attributed to the process of Activanium Blending, which involves the use of several energizing agents in Nu-Black. These energizing agents are said to be chosen and blended with end application in mind.

Modified Phenolic Coating Resin Bonds Directly to Surface

Carboline Co., 7603 Forsyth Blvd., St. Louis 5, has announced availability of a resin formulation resulting from a 2-year development program on highly modified phenolics for corrosion resistant coatings. According to the company, the departure of Phenoline 300 from conventional phenolic formulations should be apparent from the following combination of characteristics:

1. It polymerizes at room temperature in a day or less.
2. It is completely resistant to caustic soda, hot or cold.
3. It bonds directly to almost any kind of surface.
4. The unpolymerized resin fluids contain no solvents, and 98 to 100% turn into solid form upon polymerization.
5. When it sets, there is no evaporation of diluents or formation of water, no shrinkage in film formation.
6. It can absorb a substantial amount of filler without loss of strength.

For the user the important advantages of the coating are that it can be applied by brush, spray or trowel, without involving baking operations; it affords effective prevention of corrosion of steel and concrete by acids and alkalies; and patch and repair work on existing equipment, lined or unlined, handling corrosives, can be made quickly and effectively.

An important characteristic claimed for the new coating is its ability to bond to nearly any surface. The bond to steel is said to be so effective that water quenching at 70 F, after being heated to 320 F, must go to 20 repetitions or more before there is noticeable loosening. Continuous exposure to liquids under very great variations does not have any measurable effect on the bond.

New Process for Rapid Coloring of Aluminum

A new chemical process that in one operation is said to permit the protection and coloring of aluminum in such colors as yellow, blue, green, gold, brass and others, has been developed by *Enthone, Inc.,* 442 Elm St., New Haven, Conn. Called Alumox 44, the procedure developed for coloring consists of cleaning the aluminum part and then immersing it in a solution of Alumox 44 salts. Dyes can be added to the solution so that coating and dyeing occur simultaneously.

According to the company, the new process enables aluminum objects to be dyed shades of brass and gold to resemble solid metals, a matter of particular importance in view of the shortage of copper-brass alloys. Clear coatings can be produced to reduce finger marking and to protect the aluminum against weathering. The coatings are relatively non-conductive and have a thickness of approximately 0.0001 in. The process is not meant to be a substitute for electroanodizing, but was designed as a means of rapidly producing adherent colors on aluminum. In most cases, the finish is covered with clear lacquer.

Objects that have been very successfully colored include aluminum hardware, jewelry, slide fasteners, buttons, nameplates, automobile trim, goblets, picture frames, electrical fittings, lamps and pencil parts.

The salts are available as a powdered material which is added to water in a concentration of 1 lb per gal. The bath operates in the temperature range from 190 to 210 F. and coloring is accomplished in from 15 sec to 2 min.

Spoon at right has been plated with the new silver plating process, while one at left was plated by conventional methods.

Bright Silver Plating Process Eliminates Buffing

Hanson-Van Winkle-Munning Corp., Matawan, N. J., has announced a new commercial silver plating process which is said to make possible bright silver plate without buffing or scratch brushing. Until now, buffing or brushing has been a necessary step in brightening silver-plated surfaces. Called Silver-Lume, the new process is said to produce a noticeably more tarnish-resistant surface; has a wide bright range, requires no special equipment; produces an excellent deposit-distribution and uniform color; is easily controlled; and is low in cost.

Conventional plating equipment as used for ordinary cyanide silver baths is satisfactory. A new bath is prepared from silver cyanide, potassium cyanide and potassium carbonate with small amounts of Silver-Lume Brighteners A and B. The potassium salt solution is preferred over one prepared from sodium salts, as the latter has a much narrower bright range. Existing solutions can in most cases be converted to the process. Sometimes, however, such baths require special treatment; for example, with activated carbon to remove undesirable impurities. Old baths high in sodium salts, especially sodium carbonate, may require increased concentrations of both A and B Silver-Lume brighteners with subsequent electrolysis for several days in order to obtain a wide uniform brightness range.

According to the company, the process can be operated over a wide range of current densities and gives fully bright deposits at current densities higher than those used in most silver plating operations. The permissible current density depends principally on the metal content, the temperature and degree of agitation. High metal content, high temperature and vigorous agitation permit the maximum current to be used. The temperature may vary in the bath from 70 to 120 F. Under favorable conditions current densities of up to 55 asf can be employed. Thus, plating is much faster than in conventional solutions operating at current densities from 5 to 10 asf.

New Vinyl Resin Latices Are Resistant to Moisture, Grease and Chemicals

The first in a series of new vinyl resin latices is now being produced for commercial consumption by *Goodyear Tire & Rubber Co.,* Akron. Known as Pliovic Latex 300, the vinyl latex is an aqueous dispersion of a vinyl chloride copolymer.

Completion of a preliminary testing program indicates that the material should find wide use in the textile and paper coating industries. Grease-proofness, chemical resistance and resistance to moisture are some of the special properties attributed to fabrics and papers coated with the material. Physical properties are also said to be improved. Typical other uses are as pigment binders for non-woven fabrics and felt, and as a sizing for textiles.

According to the company, vinyl latices are less costly to use than other vinyl dispersions, and because they do not include volatile solvents, processing problems of toxicity and flammmability are eliminated. Another advantage is that water penetrates fibers more completely than other dispersing media so that a compounded latex will form a thin film of complete continuity with better adhesion to the fiber.

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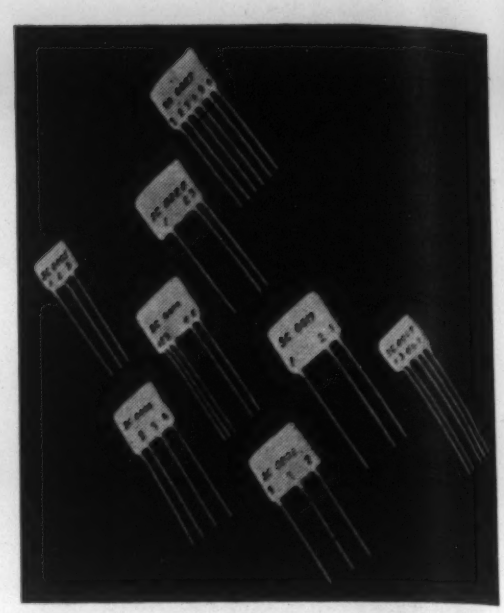
New Materials and Equipment continued

Printed Circuits Afford Faster Assembly

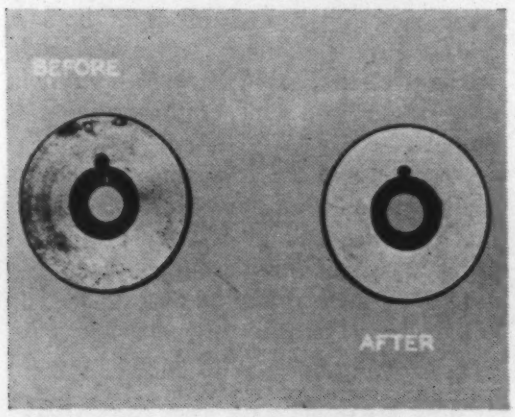
Stupakoff Ceramic and Manufacturing Co., Latrobe, Pa., has announced the development of a series of printed electrical circuits which combine in an extremely compact unit a complete resistor and capacitor electrical circuit with external leads for connecting into an electrical or electronic assembly. A number of standard circuits are available, some of which incorporate as many as six separate resistors and capacitors in a permanent circuit. Special circuits can be made to meet individual requirements.

In the production of these circuits, patterns for resistors, capacitors and conductors are "printed" on vitreous, high-dielectric ceramic plates by a silk screen process. The dielectric properties of the ceramic are used for the capacitors, while silver is used for conductors and carbon graphite or other resistance materials for resistors. After the patterns are printed, they are bonded permanently to the ceramic surface by controlled curing; then they are protected from abrasion and humidity by the application of an impervious plastic covering.

One printed circuit is said to replace from two to six individual components, with a resulting reduction of soldered connections of from 25 to 80%, depending on the circuit. The circuits also offer savings in space, reduced weight and faster assembly.



These printed circuits combine in an extremely compact unit a complete resistor and capacitor electrical circuit.



The newly developed barrel finishing and deburring compound has been used on the part at right.

Deburring and Barrel Finishing Compound Cuts Time

A newly developed deburring and barrel finishing compound currently being introduced by *Blue Magic Chemical Specialties,* 2135 Market St., Philadelphia 24, is claimed to reduce deburring time by as much as 75 to 90% and to cut deburring and finishing time in half or less. It is also said to produce absolutely uniform radii on parts such as bearing races and retainers.

Another important advantage attributed to No. S-12 Compound is that it is a good temporary rust inhibitor. A load of parts, deliberately dumped at the end of a deburring cycle, without rinsing or drying, and left exposed for 3 hr, showed no indications of rust formation.

The compound is a highly concentrated, non-dusting, granular composition, white in color and is used in small quantities, generally only ½ lb to 1 lb per load in a 32- by 30-in. barrel.

New Form of Mica Finds Use as Electric Insulation

Mica Mat, a new, paper-like material made of matted flakes of mica, has been announced by the *General Electric Co.,* Schenectady 5, N. Y. Developed in Europe, the material is now being manufactured by G.-E. in a newly adapted process similar to paper making. It is finding use in both armature windings and field coils in the manufacture of some motors and generators for electric and diesel-electric locomotives at Erie. Company engineers point out that the operation at Erie (Locomotive and Car Equipment Dept.) is one of the first American production uses of this ground insulation.

The new material is said to stand about 600 volts per mil of thickness, and its thickness is uniform within a fraction of a mil. The thickness of a wrapped conductor is now more constant than was possible with mica-glass cloth insulation, and according to company engineers, Mica Mat also has fewer electrical "holes" than mica-glass cloth.

The manufacture of the material is done by baking mica at 700 to 800 C and then suddenly quenching it with cold water, causing the mica to explode into tiny flakes. The water-mica slurry is then fed into a paper-making machine and comes out as a dry, fragile paper. This paper is impregnated with a heat resisting silicone varnish and applied to glass cloth for use as wrappers. The finished product meets the specifications of class "H" insulation.

(More News on page 146)

Reduce the use of critical alloys in gas turbine structures

N-A-X AC9115 ALLOY STEEL offers a means of reducing the use of critical alloy steels of the "stainless" type in gas turbine and similar applications. In specific cases it has replaced over half the amount of strategic material originally required, with no sacrifice of quality.

N-A-X AC9115 ALLOY STEEL has high strength and toughness values at temperatures ranging from −70° F. to +1,000° F. It can be readily cold formed into the most difficult shapes; its response to welding by any process is excellent. It must, however, be suitably coated for protection against cold or hot corrosion.

N-A-X AC9115 ALLOY STEEL is available in bars as well as flat rolled products. Investigate the outstanding properties and characteristics of this steel and, through its use, conserve the critical material so necessary to our nation.

with N-A-X AC9115

ALLOY STEEL

GREAT LAKES STEEL CORPORATION

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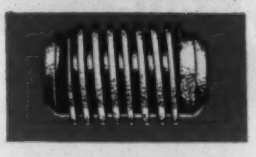
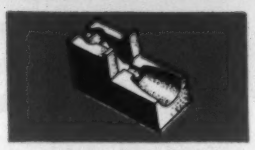
Having a hard time getting "CRITICAL" metals?

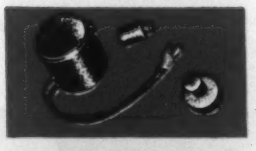
. . . as power and mercury arc rectifier tube anodes



. . . as bearings



. . . as molds and dies of many types



. . . as contacts for a wide variety of uses

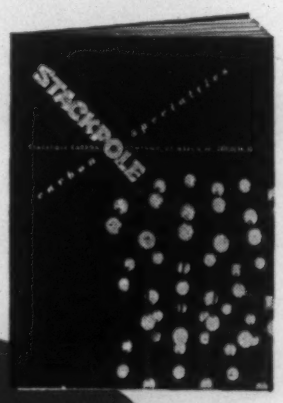
. . . as seal rings

. . . and in numerous other uses, Stackpole molded carbon and graphite materials often offer real advantages over products formed of "critical" metals that, at best, are scarce or which, at worst, are simply unobtainable.

Chemically, electrically and mechanically, carbon and graphite offer a maximum of the desirable properties of both metallic and non-metallic materials and a minimum of their disadvantages. Problems of friction, temperature, arcing, corrosion—and many others—can frequently be solved better, and at less cost.

Write for this big carbon-graphite booklet!

Stackpole Catalog 40 describes dozens of standard items and includes helpful data on the selection of carbon-graphite products.



Stackpole Carbon Company, *St. Marys, Pa.*

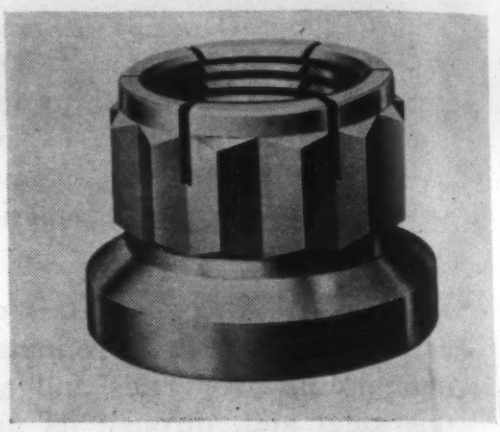
STACKPOLE

"EVERYTHING in CARBON BUT DIAMONDS"

New Materials and Equipment

External Wrenching Nut Combines High Strength with Minimum Size and Weight

Originally designed for aircraft use, an external wrenching nut made by *Standard Pressed Steel Co.*, Box 888, Jenkintown, Pa., can be applied wherever space is at a premium and high tensile strength is required.



Under latest government specifications for aircraft, this wrenching nut is approved in sizes from ¼ to 1½ in. in the NF thread series.

The Flexloc nut is said to combine extreme strength with minimum size and weight. The tensiles are consistently in excess of 160,000 psi. For example, the 1¼-in. size has a minimum tensile of 193,700 lb, yet weighs only 0.52 of a pound. Designed with a large bearing surface, it has 12-point serrations to fit standard box or socket wrenches for convenience in restricted space and close clearances.

Because it does not have to seat to lock, the fastener is a stopnut as well as a locknut, locking securely in any position on a threaded member. Furthermore, its all-metal, one piece construction is said to permit its use at temperatures as high as 550 F without loss of locking efficiency.

Hard Finishes for Aluminum Resist Abrasion

New hard coatings for aluminum where high resistance to abrasion is desired are being released to licensees by the *Aluminum Co. of America*, 801 Gulf Building, Pittsburgh 19. The coatings are said to have special value where hard, long-wearing surfaces, coupled with light

IMAGINE MAKING only 10,000 OF THESE

and a profit, too?

RADIO CASE made of Boltaron — the tough, new low-pressure formable sheet.

Any experienced plastics fabricator can do it for you by taking advantage of the low-cost molding methods that Boltaron makes possible.

Formability — Any simple or complex shape can be formed in Boltaron with low-cost molds and molding equipment.

Impact Resistance — Boltaron is unharmed by blows that dent sheet metal, shatter metal castings. Boltaron tote boxes (any shape or size) can be dropped from a second story window . . . last indefinitely.

Other Features — Boltaron can be produced in any color and in several finishes. Colors are an integral part of the Boltaron sheet, won't peel, chip, crack, or scrape off. For further details write for illustrated booklet to

BOLTA, Box 309, Lawrence, Mass.

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OFFICE MACHINE HOUSINGS
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FENDER GUARDS
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TOTE BOXES
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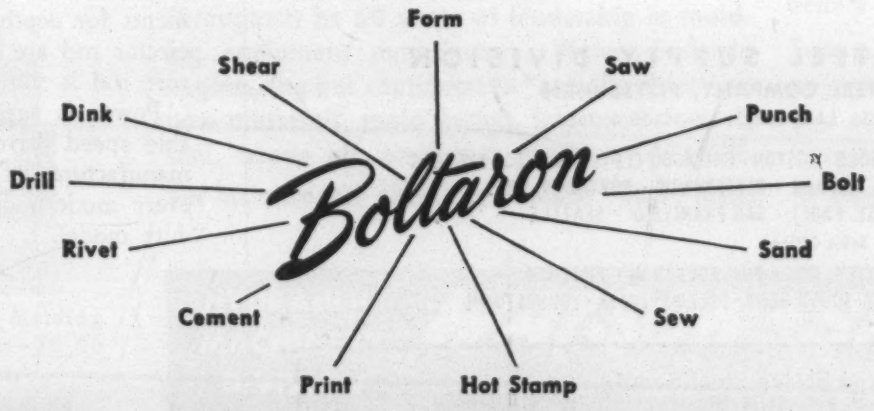

Boltaron

A BOLTA Plastic

NEW! Boltaron 6200, a plastic of remarkable chemical resistance, is available through H. N. Hartwell & Son, 947 Park Square Building, Boston, Massachusetts.

NOTE: Our Custom Molding Division specializes in injection and compression molding of all types. Write direct to Custom Molding Division, BOLTA, Lawrence, Massachusetts.

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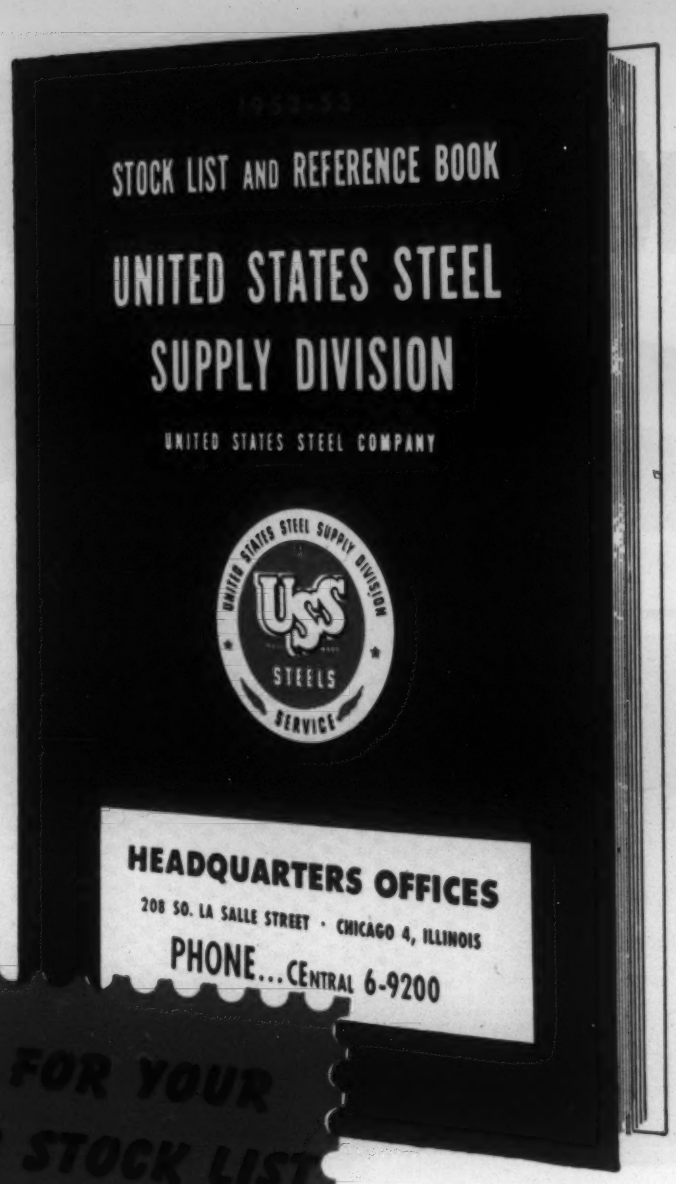
FOR QUICK, ACCURATE STEEL SELECTION



SEND NOW FOR YOUR NEW 1952-53 STOCK LIST AND REFERENCE BOOK

● This easy-to-use, illustrated steel guide is packed with useful information and features:

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UNITED STATES STEEL

New Materials and Equipment

weight, are essential, as in surfaces subjected to abrasion or erosion. They have been used extensively in aircraft equipment and orthopedic appliances.

The new finishes are anodic oxide coatings which form an integral part of the metal they protect. Intrinsically hard, aluminum oxide coatings cannot be chipped or flaked from their parent metal, and the newer types are claimed to afford superior resistance to abrasive action.

Alcoa has also acquired the U. S. patent rights to the Martin Hard Coating for aluminum from The Glenn L. Martin Co., Baltimore. The MHC finish is similar to the Alumilite coatings in hardness and structure, and is said to have been used successfully in the solution of problems of wear, abrasion, heat erosion, and corrosion in such diversified articles as gears, pinions, turbine impeller blades, nozzles, and the loading edges of high-speed airfoils.

Double Action Press for Metal Powder Parts

Arthur Colton Co., 3401 E. Lafayette Ave., Detroit, has announced a new press, designated Model 360, for powdered metal applications. This press is double-action type with crank action top punch delivering 35 tons pressure, and toggle action bottom motion also delivering 35 tons pressure. Depth of fill is 3 in., and maximum tablet diameter is 3 in. Adjustments for depth of fill, lower punch and ejector rod are conveniently located. The core rod is stationary.

Power is supplied by a 7½-h.p. variable speed drive motor. The design and manufacture of the press incorporates every modern design in this new heavy-duty model.

Spray Booth Vinyl-Type Paint Has High Tensile Strength

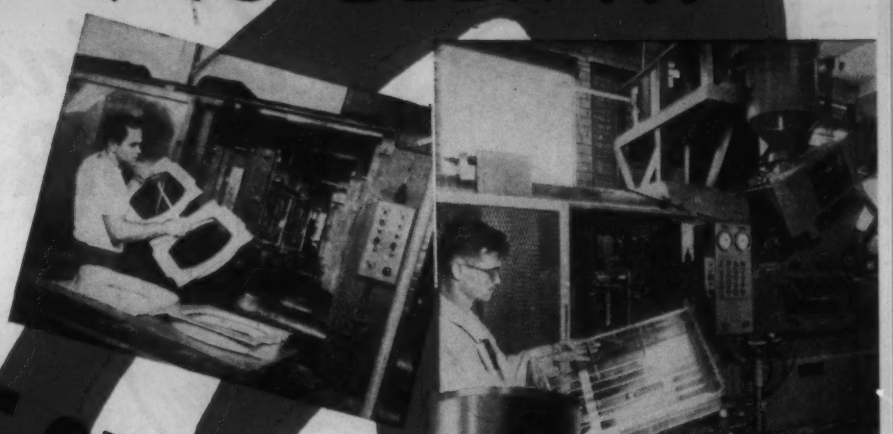
A new vinyl-type paint spray booth coating material, Vincote, is currently being offered by *Detrex Corp.*, Detroit 32. Especially developed for use on the side walls of both water-wash and dry paint spray booths, the material is said to possess

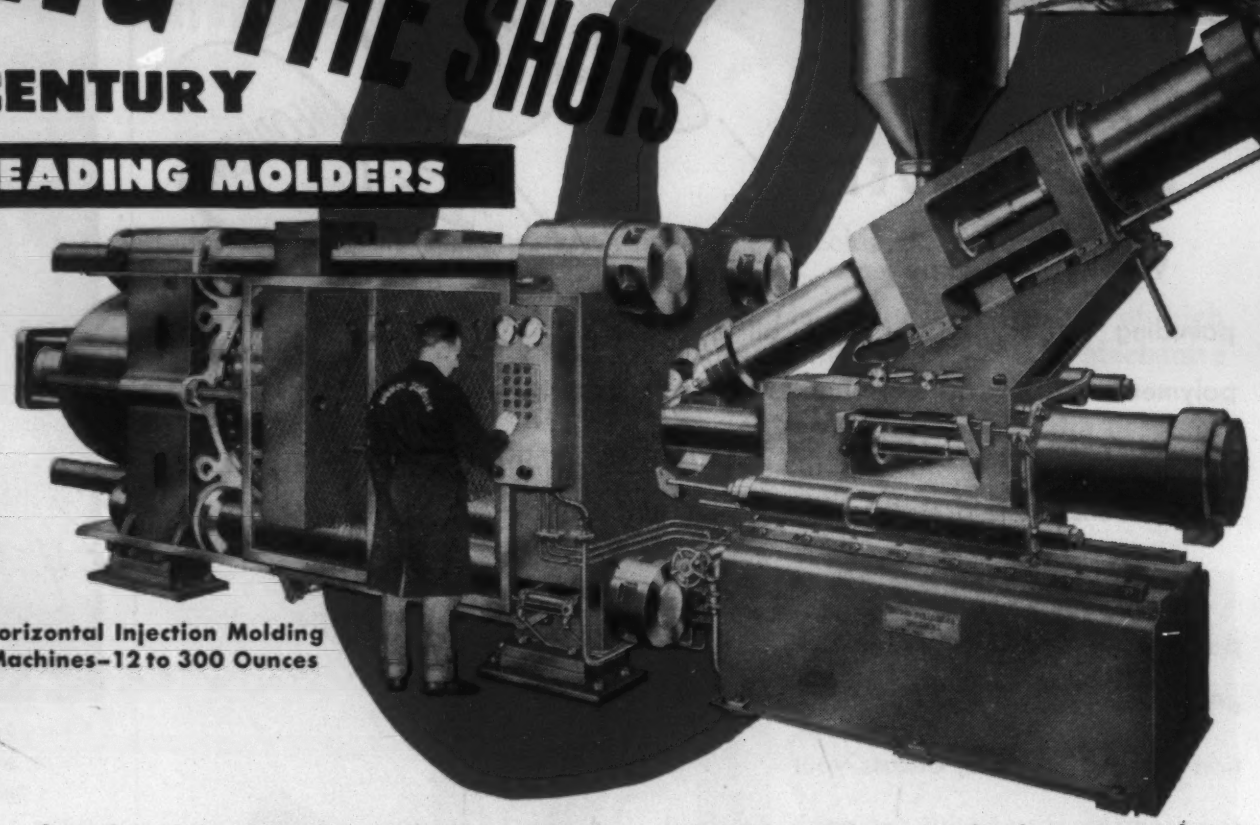
WATSON-STILLMAN HAS BEEN...

CALLING THE SHOTS

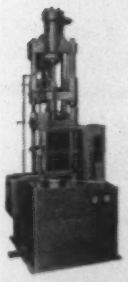
Over HALF A CENTURY

for AMERICA'S LEADING MOLDERS



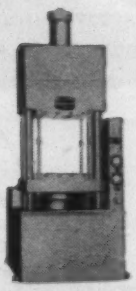


Horizontal Injection Molding Machines–12 to 300 Ounces

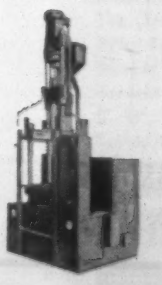


2 Ounce Semi-Automatic Injection Molding Machines.

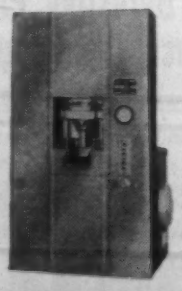
Compression Molding Presses — 50 to 1200 Tons.



Transfer Molding Machines—30 to 1200 Tons.



Vertical Injection Molding Machines — 1, 2, and 6 ounces.



Preform Tableting Machines—10 and 100 Tons.

Growth and development of plastics molding as an *industry* has so impressively accelerated during the past few years that we are inclined to regard it as a youngster in *technique*. Actually, most current "innovations" in plastics equipment are rooted in experimental work going back more than 50 years to the days of celluloid collars and the first plastic billiard balls . . . to the pioneering days of Watson-Stillman research in what then gave slight promise of becoming the modern giant plastics industry of today.

Throughout its 50 years of leadership in molding equipment manufacture, Watson-Stillman engineering has continued to "call the shots" on new materials, mold design, improved controls and, above all, on larger machine CAPACITY.

For instance, the presently popular "new" trend toward increasing capacity by means of *preplasticing* units was introduced by Watson-Stillman years ago . . . tested, improved, perfected through original research in shop and field by Watson-Stillman engineers . . . and has been successfully employed on Watson-Stillman units from 12 to 300 ounces capacity for years.

Each and every Watson-Stillman Machine is rated for its minimum capacity. This assures a margin of safety in Production . . . W-S Machines *deliver the goods.*

Today, as for more than fifty years past, it will pay you to consult Watson-Stillman *first* when you are molding by compression, transfer and injection techniques or when planning expansion or a new plant.

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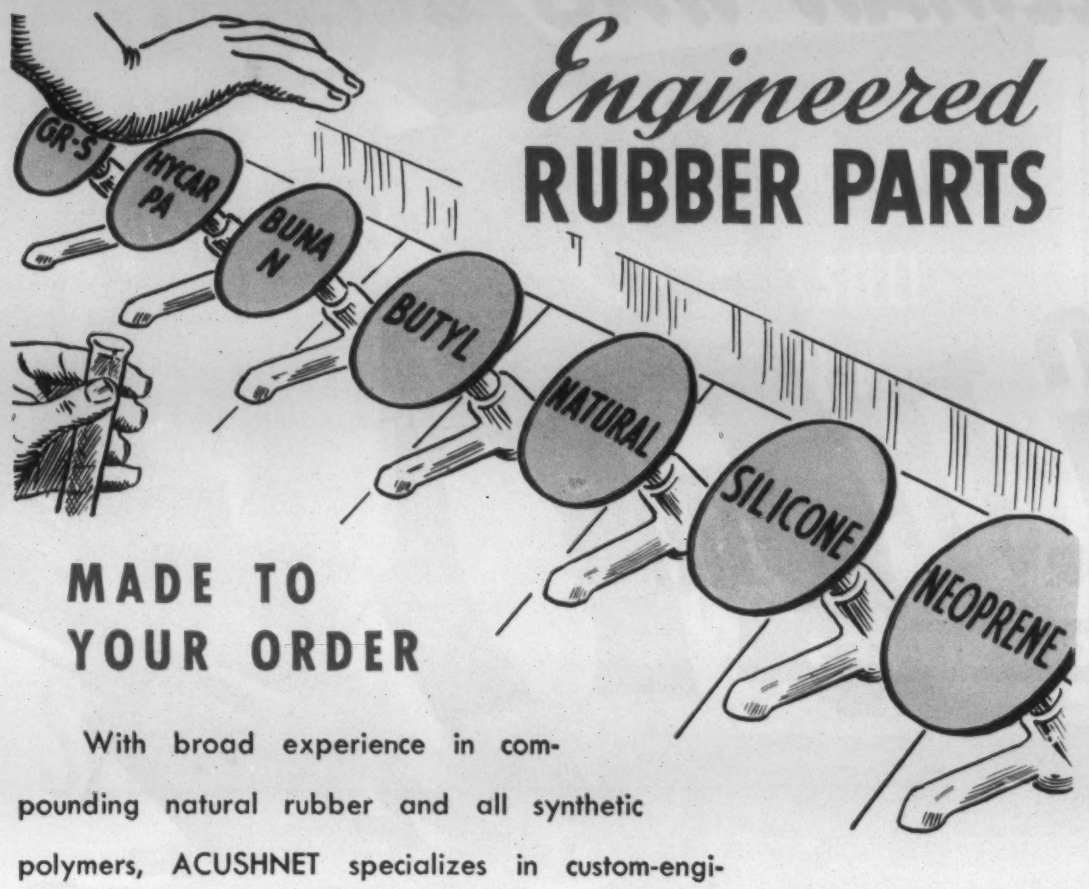

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Over-spray paint can be peeled off the booth wall because of the new vinyl-type paint's low adhesive properties.

rapid drying properties and when sprayed on a booth wall, to form a tough plastic film with exceptionally high tensile strength. Vincote is impervious to paint, enamel, lacquer and water.

The low adhesive properties of this material make booth maintenance a simple and rapid operation. When the paint overspray has built up to a point where its removal is indicated, the coating and all over-sprayed paint is merely peeled off in large, easily removed sheets.

Vincote can be applied to walls with any standard spray equipment, and a gallon will cover from 275 to 400 sq ft, depending upon the desired thickness.

Alkaline Derusting Process Simultaneously Cleans and Derusts

Announcement of the development of a new alkaline derusting process for steel, cast iron, malleable iron and other iron alloys has been made by *Enthone, Inc.*, 442 Elm St., New Haven, Conn. The process is stated to be unique in that no acid is required in the procedure with the attendant advantages of elimination of subsequent rusting, no attack on the base

"The high standards set for our product"... met by MEEHANITE castings

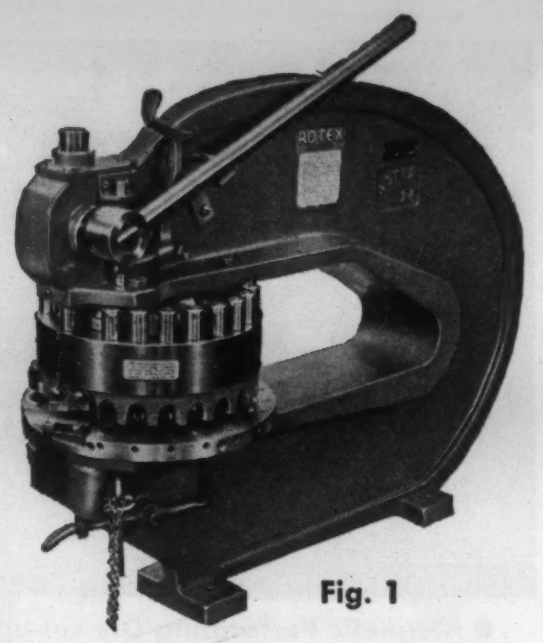

Fig. 1

The headline quoted above is a statement made by the Rotex Punch Company, Oakland, California, manufacturers of a line of Quick Change Punch Presses (Fig. 1). Meehanite castings are used exclusively in the manufacture of these presses and the manufacturer states further: "The reason for this choice is because of their higher tensile strength, a consistent absence of blow holes and hard wearing qualities. We also find that Meehanite castings are very readily machined."

The fundamental components are shown in Fig. 2.

This is another example of the maintenance of high quality standards through the specification of Meehanite castings.

If you have a casting problem involving the need for something better, remember that "Meehanite Means Better Castings" and consult your Meehanite foundry.

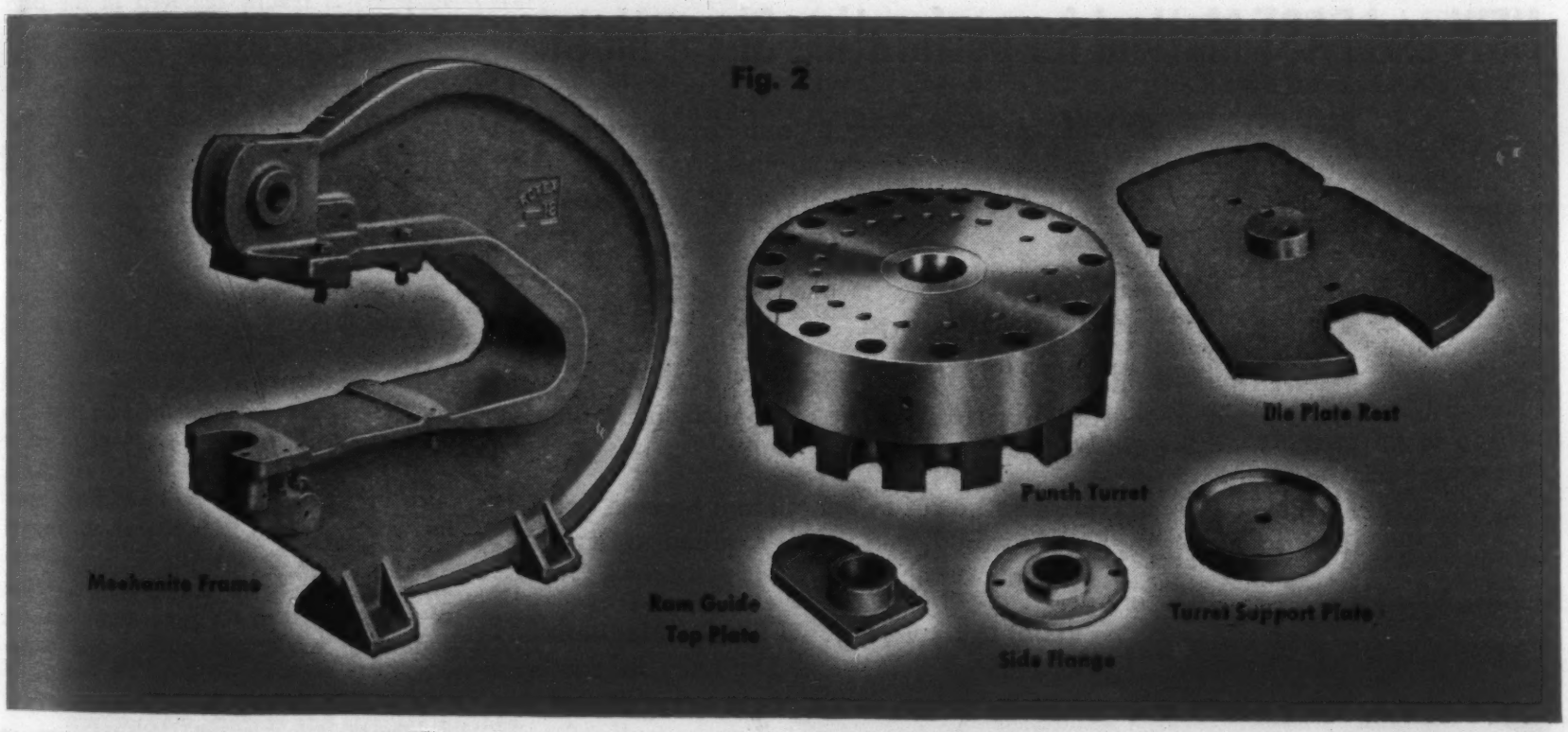

Fig. 2

Take *YOUR* Casting Problem To A MEEHANITE FOUNDRY

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Bernett Foundry & Machine Co.	Irvington, New Jersey
E. W. Bliss Co.	Hastings, Mich. and Canton, O.
Builders Iron Foundry	Providence, Rhode Island
Compton Foundry	Compton, Calif.
Continental Gin Co.	Birmingham, Alabama
Crawford & Doherty Foundry Co.	Portland, Oregon
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Empire Pattern & Foundry Co.	Tulsa, Oklahoma
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Hardinge Company, Inc.	New York, New York
Hardinge Manufacturing Co.	York, Pennsylvania
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
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The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Ind.
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
Valley Iron Works, Inc.	St. Paul, Minnesota
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

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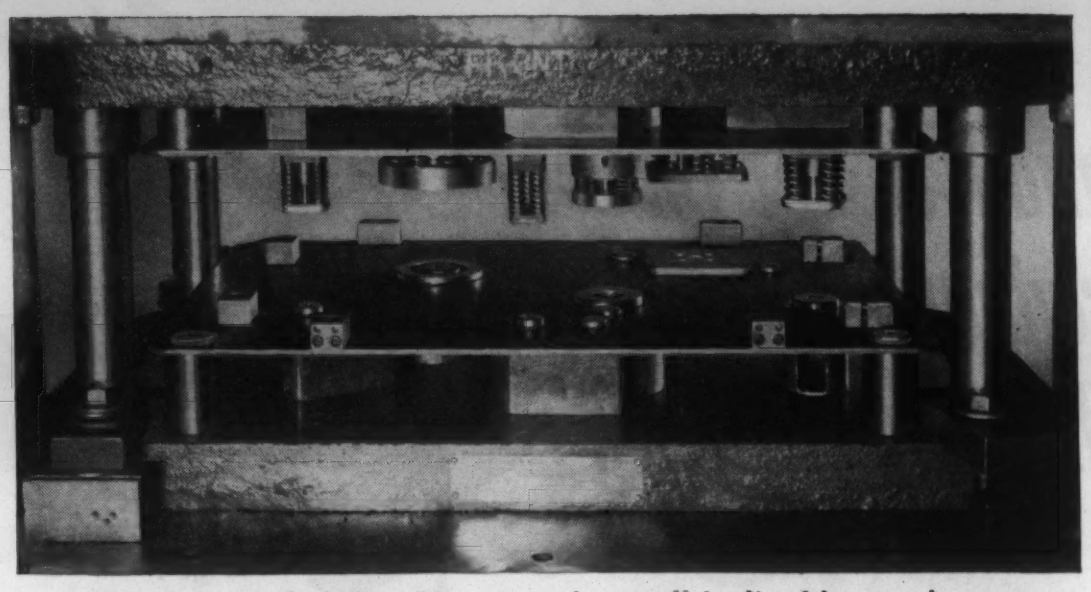

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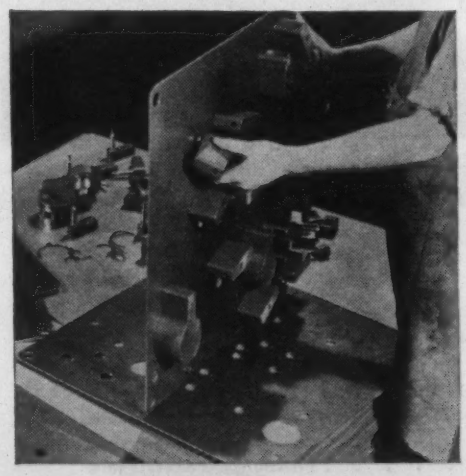
HOLD CLOSE TOLERANCES. Hole centers may be held to .0005" accuracy or as close as can be jig bored.

GREATER PUNCH AND DIE LIFE. Concentricity of punch and die assured thus giving uniform clearance around punch, increasing punch and die life.

SAVE FLOOR SPACE. Die storage cut to a minimum because only the 2 locating templets are stored...all that is required to duplicate the set-up.



● Die retainers complete with bushings being inserted in die templet.

REDUCE DIE COSTS. Whistler Magnetic Perforating Punch and Die units are used repeatedly for different hole arrangements. When completing one job, remove all units from templet and put them into service on the next different set-up. Combine any number of hole sizes and shapes. Punch and die costs are amortized over continued re-use in many jobs.

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New Materials and Equipment

metal, and speed of operation. High carbon steels that are prone to be discolored even in inhibited acids can be rapidly derusted without any trace of tarnish or attack, and because the process is alkaline in nature, it simultaneously cleans and derusts.

The work to be derusted is made the cathode in a solution of Enthone derusting compound for from a few seconds to several minutes, depending upon the condition of the surface. Tests made comparing the speed of derusting with hot sulfuric or cold hydrochloric acids have shown that derusting can be accomplished in a fraction of the time. In one test, complete rust and scale removal was accomplished in 2 min. as against 45 min. for acid pickling.

Operation of the bath is said to be simple. Parts heavily contaminated with grease should be first degreased. However, light oil is readily removed in the bath. The parts are then immersed in the solution, where they are made the cathode. A wide range of current density can be employed from 5 to several hundred amp per sq ft. Speed of derusting is dependent upon the current density used. The bath is simple to control and is done by titration. After derusting, the object is clean and bright. Longer treatment does not result in any attack upon the metal being pickled. Therefore, close watching of the pickling process is not required.

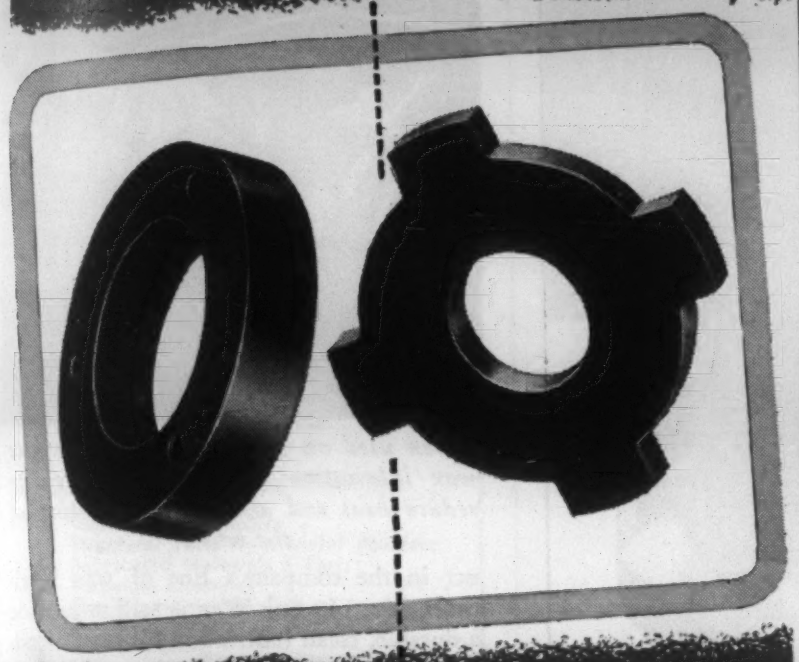
One of the chief advantages claimed for the process is due to the fact that it is alkaline and there is no tendency to cause surrounding equipment to be corroded, such as occurs with acid pickling processes. In addition, subsequent rusting of the part that is derusted is not accelerated, whereas, with acid pickling, traces of acid trapped in the pores may leak out and cause accelerated rusting and corrosion.

It is believed that the new process is of particular value to the military, as in emergencies it can be used at sea or on the field with only the assistance of a portable generator.

Wax Lubrication Facilitates Metal Working Operations

A blend of special solid waxes put up in stick form in order to facilitate use in certain types of metal-working operations is now being offered by *S. C. Johnson & Son, Inc.*, Racine, Wis. The newest prod-

Every one **IMPERVIOUS** to hot corrosive liquids



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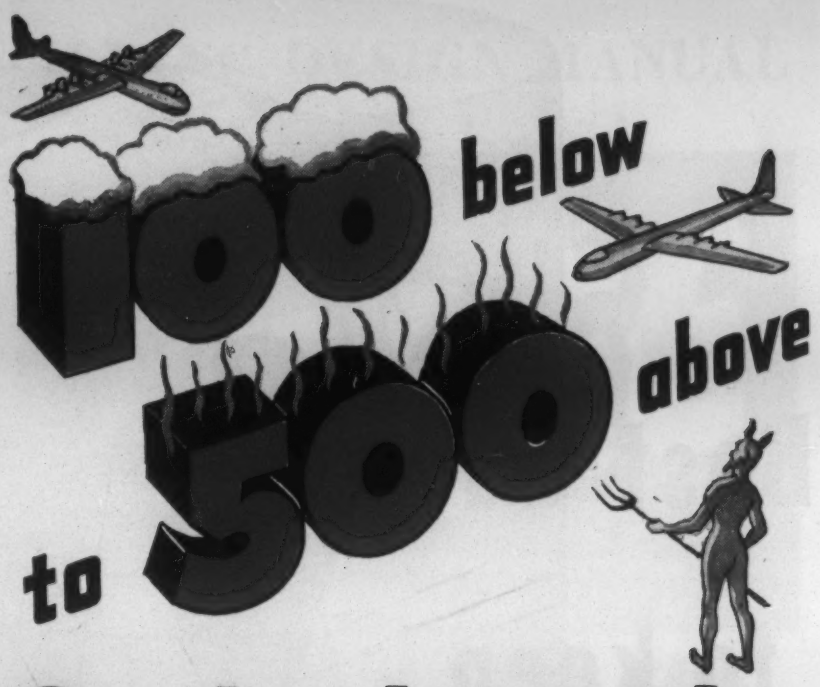

Cohrlastic

silicone coated fabrics

The makers of Cohrlastic products, for the first time, bring to designers and engineers, a comprehensive series of silicone rubber-coated fabrics for temperatures ranging from —100 to +500°F. Operating in the upper and lower limits, most synthetics and all natural rubbers crack and shatter or melt and disintegrate.

These new Cohrlastic fabrics withstand extreme temperatures and still retain their resiliency and flexibility. This is important for aircraft engine gaskets, washers, and diaphragms. These fabrics also possess high dielectric strength and resist hot oil, ozone and most chemicals.

Cohrlastic fabrics come in rolls 36" wide and various thicknesses. They are easily cut with shears and shaped for expansion joints and ducting. Finished gaskets and diaphragms, flat or convoluted may be ordered direct from the factory.

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Temperature resistant Fiberglas coated with silicone rubber for operations ranging from —70 to +500°F.

THICKNESSES: .007, .010, .016, .032 inches.

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Best way to keep a Head

Vapor-from-Paper STOPS RUST — Now Cost of Protecting Diesel Cylinder Heads is Cut from $4.70 to $1.31

You're looking at a revolutionary way to keep a Diesel cylinder head from rusting.

A leading locomotive firm used to dip heads in an inflammable cleansing liquid. Then moisture had to be removed. This called for cranes and fire precautions. Dried with an air hose, this cylinder head was dipped into a varnish-like solution. To keep the sticky coating in place, waxed paper and heavy wooden boxes were "musts". Unpacking involved the same troubles in reverse. A couple of hours with a scrubbing brush came before the head could be installed in a Diesel.

Today, vapor-from-paper stops rust! This magic-like paper is Angier VPI* Wrap. It gives off an invisible protective vapor that is clean . . . SAFE! As the vapor permeates into deepest cavities, both air and moisture are made harmless to shiny cylinder heads. No grease or oil is necessary. Now packaging costs are down to $1.31 from $4.70. And this doesn't include an average freight savings of 24% on the thousands of different locomotive parts that now are VPI-protected. All parts are ready to use when received . . . a godsend to men in the repair shops. No bulky equipment is required, so valuable floor space is saved.

If you ship or store metal parts or products, Angier VPI Wrap is meant for you! It may be used as a box liner or an envelope as well as a container insert. For "VPI Facts", write to the most experienced name in vapor rust preventives . . . Angier Corporation, Framingham 14, Mass.

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VPI* WRAP

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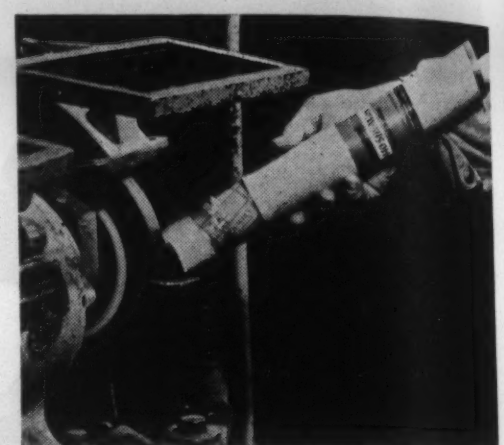
New Materials and Equipment



When used on grinding wheels, the new wax lubrication provides lubrication to reduce heat and also lessens clogging of the wheel.

uct in the company's line of wax lubricants, No. 140 Stik-Wax is said to provide a durable, clean lubrication for metal sanding, metal sawing, pipe cutting and threading, drilling, tapping, grinding and flush riveting.

Lubrication with the new wax is said to extend the life of saws, drills and cutting tools as well as sanding and grinding surfaces. Tests show that the product also provides a better finish on the worked pieces. Burrs are eliminated when metal is cut or drilled, and a smoother finish is achieved when grinding or sanding metal surfaces.

Stik-Wax can be applied manually, as needed, by the operator or set in a position so that it is automatically applied as the machine operates.

New Control Instrument Measures Fluorescence by Ultraviolet

A new instrument for better control in porcelain enamel plants, known as a Fluoreter, has been introduced by *Ferro Corp.*, 4150 E. 56th St., Cleveland 5. The instrument works on the principle of fluorescence caused by ultraviolet light. Among the 3000 materials which will fluoresce, or emit light when exposed to ultraviolet rays, is mineral oil. Due to its unsaponifiable nature, mineral oil is a hazard in the production of porcelain enameled objects.

By using the light portable Fluoreter (about the size of a large flashlight) spot checks can be made for mineral oil contamination during all phases of production

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New Materials and Equipment

on bisque forms, in the pickle room, in drawing compounds.

Another use of the instrument is to determine the pH of various solutions. Many chemicals are known as fluorescent indicators because they vary in color when under ultraviolet light, according to the pH present. By adding a fluorescent indicator to the solution to be checked, a Fluoreter can be used to tell the approximate pH of the solution.

Still another use of the instrument is to identify mill addition materials and other chemicals which appear white in ordinary light, but which are actually vari-colored when exposed to ultraviolet light.

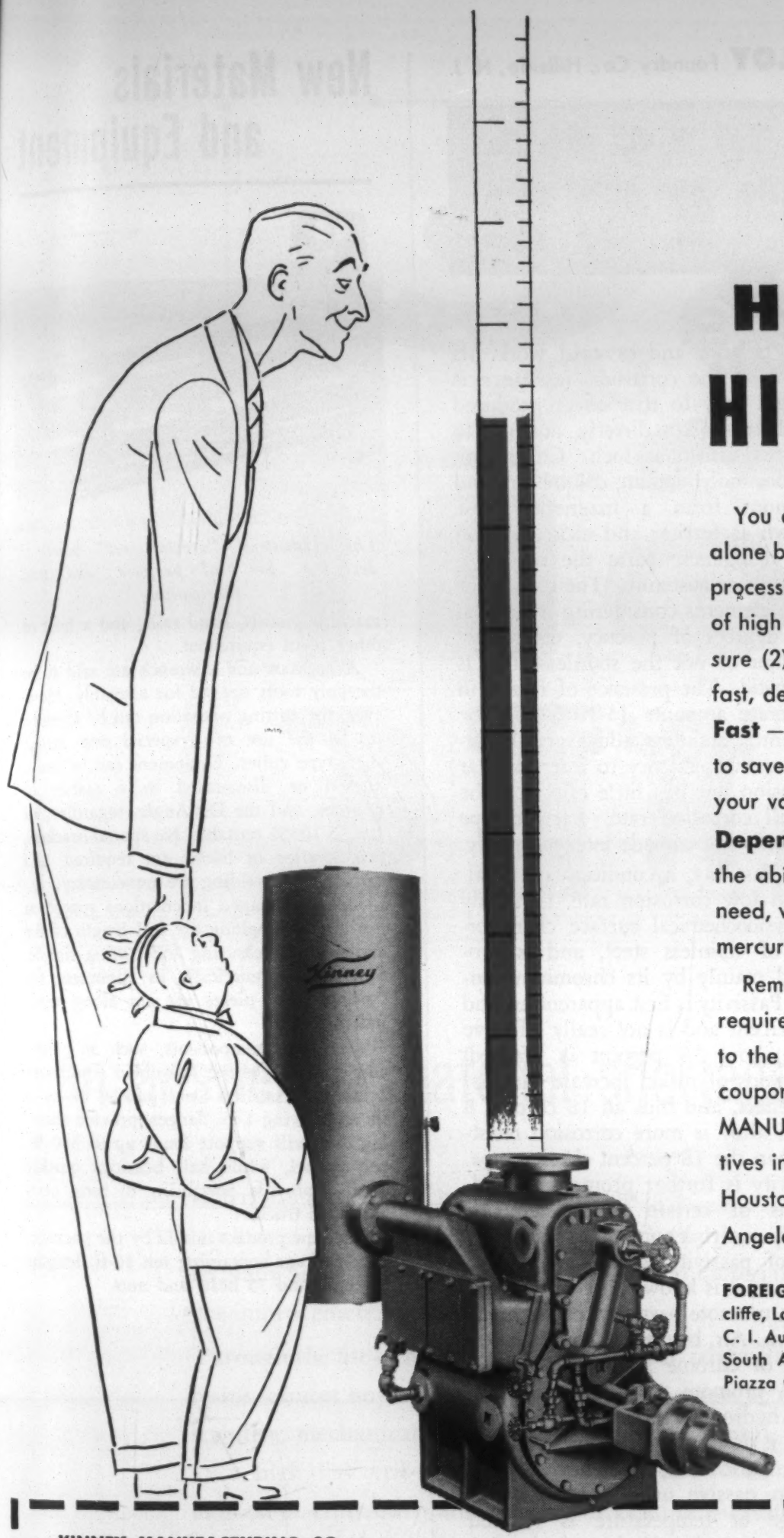
Compound for Controlled Etching of Aluminum and Aluminum Alloys

A new compound for the controlled etching of aluminum and its alloys has been developed by the *Silver Star Chemical Corp.*, 58 Watts St., New York. Star Etch is said to eliminate the problems of foaming, sludging and hard scale formation, while sharply reducing the hazards associated with conventional etching.

Production of a uniform controlled etch is possible by either dipping or mechanical spraying. The bath is easy to operate, easy to maintain and economical to users.

Industrial "Erector Set" Finds Wide Application in Manufacturing Plants

Acme Steel Co., 2840 Archer Ave., Chicago 8, has announced the availability, in limited supply, of DexAngle, a 10-ft. long, 3- by 1.5- by 0.080-in. slotted-leg galvanized steel angle designed for all-purpose industrial fabrication. This industrial "erector set" unit has lengthwise rows of slots which permit the rapid assembly by bolting of shelving, bins, scaffolding, ladders, assembly tables, motor and machinery mounts, coat and hat racks, partitions, chairs, cabinets, desks, conveyor-line structures, benches, skids, trays,



How Low is a HIGH VACUUM?

You can't measure a working vacuum by *pressure* alone because *time* also is a big factor in any vacuum processing operation. To provide these two essentials of high vacuum — (1) the *required low absolute pressure* (2) in the *shortest possible time* — is the job for fast, dependable Kinney High Vacuum Pumps.

Fast — Kinney High Vacuum Pumps have the ability to save processing time by speeding up the tempo of your vacuum operations.

Dependable — Kinney High Vacuum Pumps have the ability and stamina to produce the vacuum you need, whether it's measured in fractions of an inch of mercury or fractions of a micron.

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TECHNICAL TOPICS

Factors Affecting the Corrosion Resistance of Stainless Steels

Norman S. Mott
Chief Chemist and Metallurgist

Much doubt exists today as to the influence on the corrosion resistance of stainless alloys of such factors as metal surface condition, grain size, cold working, chemical composition, magnetism and passivity. This discussion will attempt to explain these factors and their influence.

1. The smoother the surface of the metal, the better the corrosion resistance; thus ground or machined surfaces are better than those which are sand blasted, and a polished surface is the best.

2. Small grain size in austenitic stainless steels decreases the tendency to intergranular attack, but the general overall corrosion rate is not affected to any great extent by grain size.

3. Cold working austenitic stainless steels decreases the tendency to intergranular attack through the production of a small grain size and precipitation of carbides along strain lines rather than at the grain boundaries. Its effect on the overall corrosion rate however is to increase it.

4. Chemical elements such as chromium and aluminum are corrosion resistant in oxidizing acids and others such as nickel, copper and tungsten are corrosion resistant in reducing baths. Some, such as molybdenum and silicon, are resistant to both. Alloyed, these properties may reverse to a certain extent; however, in general, their corrosion tendencies hold true for the more gross additions.

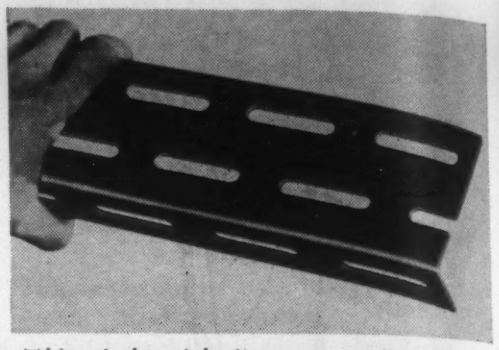
5. Magnetism in stainless steel is produced by the chemical composition balance and/or cold work. Its effect on the corrosion resistance is related only to that effect produced by these sources directly, and not to the magnetism as such. Chromium, silicon, molybdenum, columbium and titanium form a magnetic phase known as ferrite; and nickel, carbon and manganese form the non-magnetic phase austenite. The balance of these elements considering their relative degrees of potency, determines whether or not the stainless steel is magnetic. The presence of ferrite in moderate amounts (5-10%) in the austenitic stainless alloys greatly decreases the tendency to intergranular corrosion but has little effect on the overall corrosion rate. Ferritic type alloys do not corrode intergranularly.

6. Passivity, a condition of nobility on low corrosion rate, is mainly a physicochemical surface characteristic of stainless steel, and is produced mainly by its chromium content. Passivity is first apparent around 12 percent and is not really effective until about 18 percent is reached. Additions of nickel increase the passive effect, and thus an 18 chrome 8 nickel alloy is more corrosion resistant than the 18 percent chrome type. Passivity is further promoted by additions of certain other elements, mainly molybdenum. The exact nature of passivity is still in dispute; however, it is known that while some media promote passivity; others break it down. Air, oxygen, adsorbed gases, nitric or chrome acids, and a high polish promote passivity and chlorides, hydrochloric or sulfuric acids break it down. In dilute hydrochloric and sulfuric acids, 18-8S and 18-SMo remain passive until a critical percentage or temperature is reached then passivity breaks down and active violent corrosion proceeds.

Copies of this article reprinted on heavy stock for convenient filing are available on request.

The **COOPER ALLOY** Foundry Co., Hillside, N. J.

New Materials and Equipment



This industrial "erector set" unit is designed for all-purpose industrial fabrication.

machine guards, hand rails, and a host of other plant equipment.

A hacksaw and a wrench are said to be the only tools needed for assembly. However, the cutting operation can be speeded up by the use of a special one-stroke sheer-type cutter. Equipment can be built, altered or dismantled in a matter of minutes, and the DexAngle, regardless of size, is 100% reusable. No special brackets, braces, clips or hooks are required, and drilling and welding are unnecessary.

Diamond-shaped indentations spaced at 3-in. intervals along the full length of the angle make measuring and cutting simple. Slots are automatically in alignment for bolting when pieces are cut along these indentations.

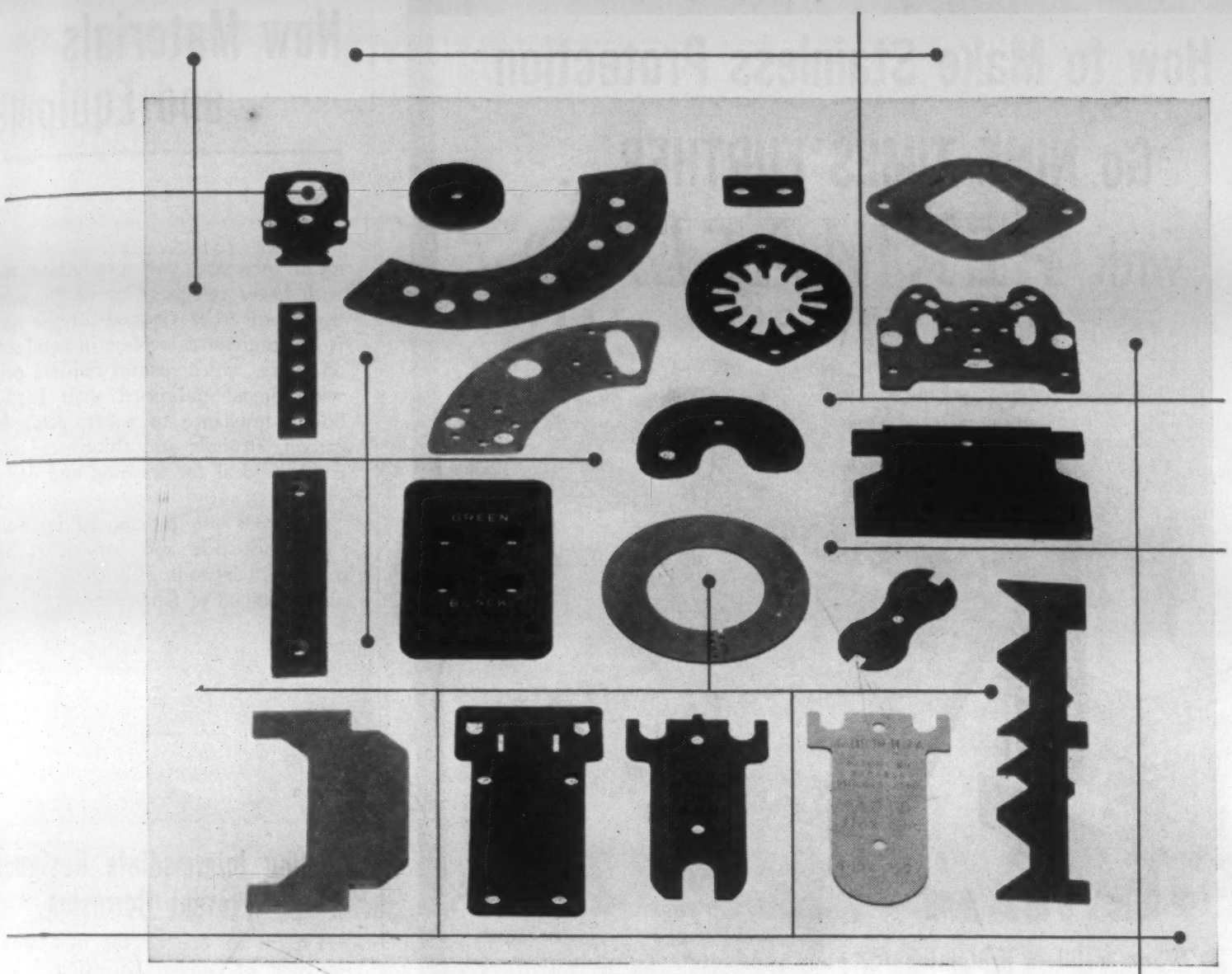
Auxilliary components, such as panels and casters, give the assembled equipment a wider versatility. Steel panels, 36 by 6 in. and having 1-in. flanges, provide shelving that will support loads up to 300 lb. per pannel, while ball bearings quickly applied provide portability to bins, carts and hand trucks.

The new product is sold by the package, each package containing ten 10-ft. lengths of angle and 75 bolts and nuts.

New Adhesive Resistant to Water and Variety of Chemicals

Fabricators of vinyl sheeting and pyroxalin coated fabrics have been faced with the probem of efficiently adhering these surfaces to themselves and to other materials, such as cardboard, wood, metal and plastics. Pliobond, an adhesive offered by *Bond Adhesive Co.*, 537 Johnson Ave., Brooklyn 37, is said to provide an effective solution to the problem.

The material is characterized by its positive initial grab, which can, in many cases,



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When you feel the pinch of material shortages... investigate LAMICOID. This thermosetting laminated plastic is so versatile that it can be produced with exactly the qualities you need. In many fields, LAMICOID has effectively solved material shortages... often resulting in product improvements, too.

Through the use of fillers such as glass, nylon, paper, fabric, etc., with a variety of synthetic resins, almost any combination of properties can be achieved. Light weight, dimensional stability, mechanical strength, high impact strength, abrasion resistance, moisture resistance, high dielectric strength, low power factor—these characteristics plus such advantages as good machinability and punchability can be built into LAMICOID, to suit almost any need.

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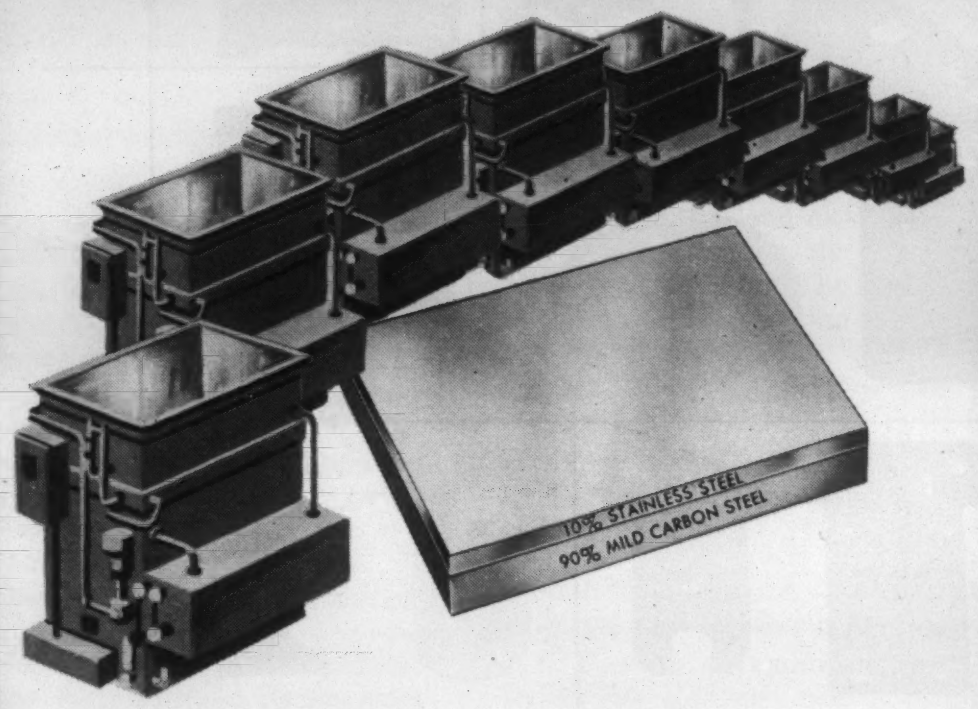
How to Make Stainless Protection Go NINE TIMES FURTHER... with PERMACLAD

STAINLESS CLAD STEEL



Want stainless protection for your product or equipment—without wasting stainless steel? You'll get it at low cost—with PERMACLAD!

A 10% layer of stainless, inseparably welded to a 90% mild steel backing, gives PERMACLAD the surface characteristics of solid stainless *and* the easy forming qualities of carbon steel. This means real savings in corrosion resistance and in fabrication as well. For you can cold-form PERMACLAD with ease, draw it deeper without intermediate annealing, actually form it into products impossible with many other materials.

Even with the most severe draw, the percentage of cladding (which can be 20% or more if desired) never varies. And the stainless layer remains inseparably welded to its backing. For gleaming, stainless products and corrosion resistant equipment, design and build with PERMACLAD. The coupon below brings you full details in our new 8-page folder (P-97).

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Other Products: A.W. ALGRIP ABRASIVE Floor Plate • A.W. SUPER-DIAMOND Floor Plate • Plates • Sheets • Strip • (Alloy and Special Grades)

New Materials and Equipment

mean increased unit production coupled with fewer rejects. One of the most unusual properties claimed for the adhesive is its progressive increase in bond strength on aging, which insures finished products with almost unlimited shelf life. Pliobond's resistance to water, acids, hydrocarbon, alcohols and chlorinated solvents make it ideal for washing and dry cleaning.

Materials can be bonded by the wet-stick, tack-stick and solvent reactivated methods, depending entirely upon the user's method of fabrication.

Coating Intermediate Designed to Prevent Corrosion

Typical of one of the new chemicals designed to combat corrosion is a new coating intermediate, R-108, announced by the Chemical Div., *General Electric Co.*, Pittsfield, Mass. Consisting basically of chemically modified, phenolic derivations, R-108 not only shows resistance to acids and solvents, but is also impervious to alkalies, oxidizing materials, and other corrosives against which conventional phenolics have limited or no usefulness.

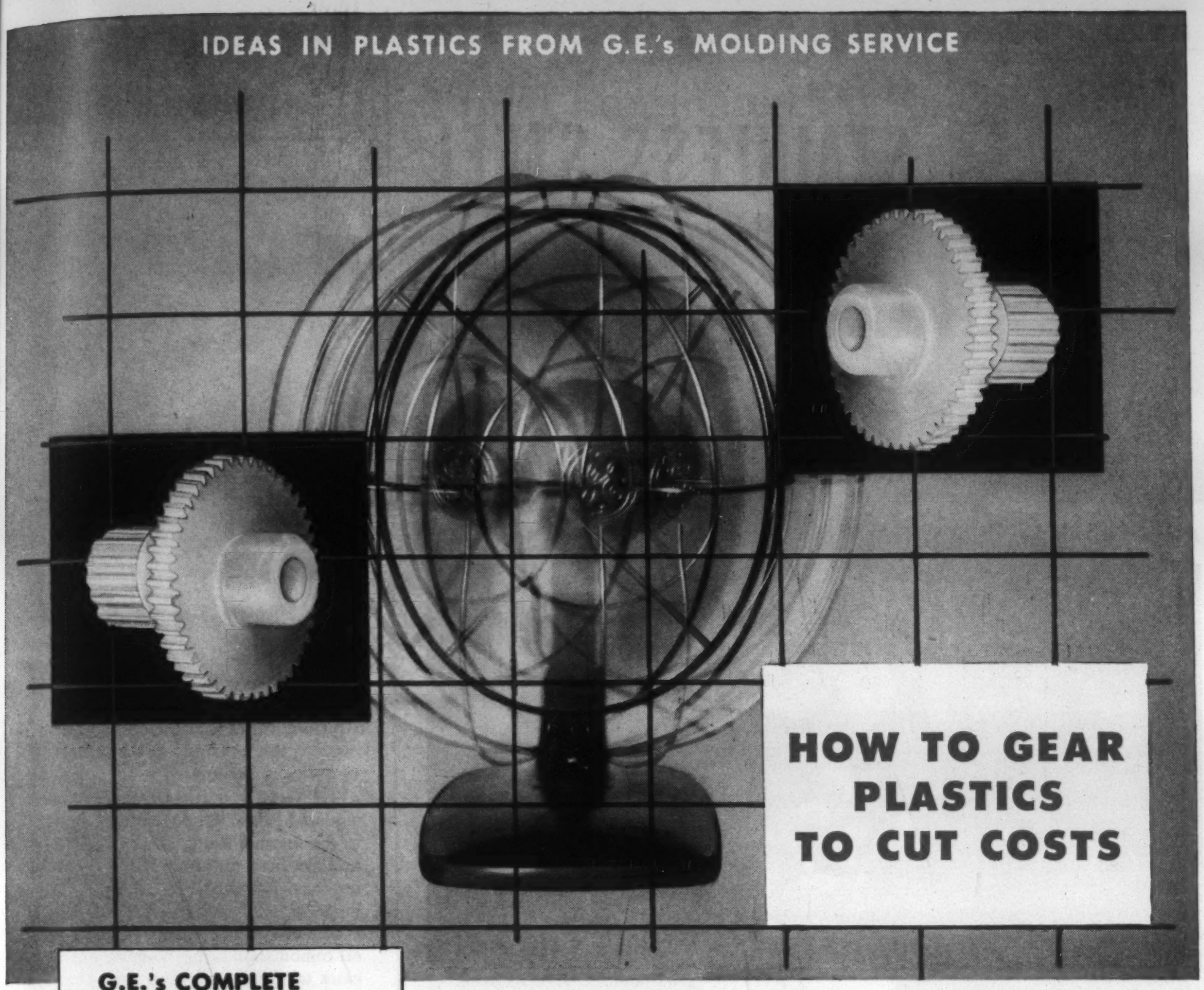
Shortages of alloy materials and needs for greater chemical resistance have created demands for R-108 finishes in the container, closure and metal decorating fields; and in the chemical process industries, tank cars, storage tanks, piping, valve bodies and filter press plates are being protected from corrosion.

Tilting Type Melting Furnace for Kirksite Metal

A 25,000-lb hydraulic tilting type melting pot furnace is currently being introduced by *Bellevue Industrial Furnace Co.*, 2620 Crane Ave., Detroit 14. The installation is designed for Kirksite metal.

Furnace and pot are tilted by means of hydraulic cylinders which are completely piped with flow control valves installed in oil lines, allowing adjustment of flow control to give desired tilting speed. The

IDEAS IN PLASTICS FROM G.E.'s MOLDING SERVICE



HOW TO GEAR PLASTICS TO CUT COSTS

G.E.'s COMPLETE MOLDING SERVICE OFFERS YOU —

- ✓ Complete mold-making facilities
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- ✓ Injection presses from 3 to 208 ozs.
- ✓ Compression presses from 3 to 36 ins.
- ✓ Complete extrusion facilities
- ✓ Complete silicone rubber fabricating facilities
- ✓ Complete molded mycalex facilities

PLUS the benefit of 60 years' experience in designing, engineering and molding plastics parts.

These molded *plastics* gears, replacing *metal* in an oscillating fan, are an excellent example of how General Electric's *complete* plastics molding service can cut costs for customers—in this case, *by no less than 63%!*

Part of this substantial saving was accomplished by substituting a nylon gear and pinion, molded as a unit, in place of a steel pinion and laminated plastics gear which required hobbing, cutting and assembling. Besides reducing costs, the new plastics gears wear better and operate more quietly.

You can depend on General Electric's *complete* molding service for cost-saving ideas like this. Perhaps this example will suggest some use for molded plastics in *your* business. If so, G.E. will be glad to work with you. One of the world's largest plastics molders, G.E. has the "know-how" and facilities to produce your biggest jobs efficiently and economically.

For information, just write to General Electric Company, Section M-2, Chemical Division, Pittsfield, Massachusetts.

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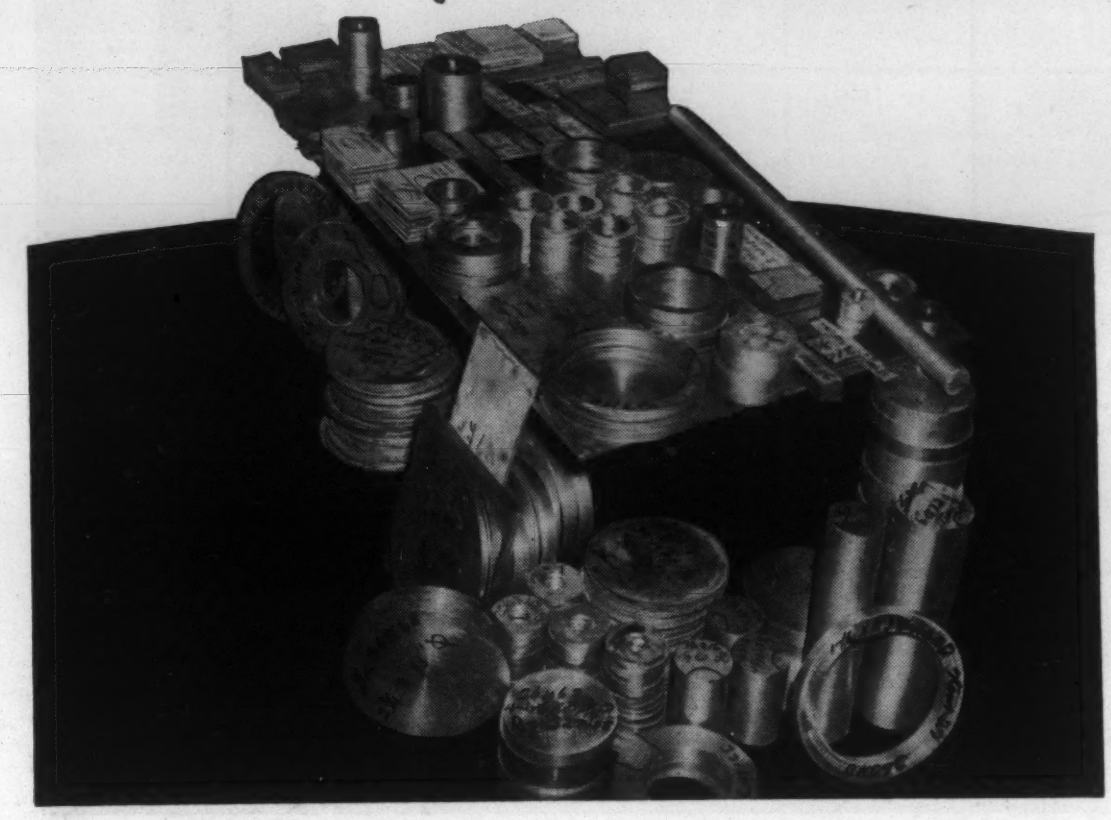
if it's

STAINLESS STEEL

come to

G. O. CARLSON, INC.



This is an illustration of the wide variety of "Small-in-Size" Stainless Steel items being prepared for shipment in our shipping room.

We are prepared and equipped to supply you with these small pieces that are *TOO OFTEN* difficult to secure. G. O. Carlson, Inc., recognizes the need of this service to fill your requirements for small items that are as necessary to complete a project as are the large pieces.

Therefore, we have planned our production so that we can supply you the smallest, equally as well as the largest plates, tank heads, forgings, bars, sheets (#1 Finish), etc.

G. O. Carlson, Inc., is a dependable source of supply for quality stainless steels.

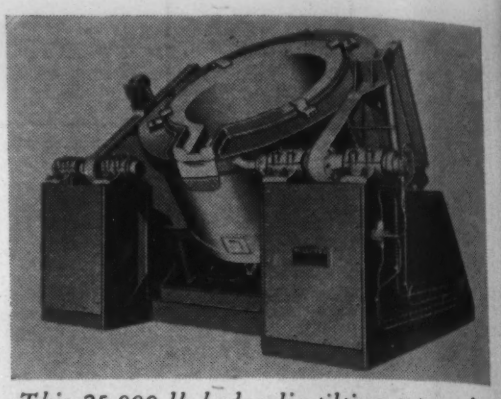
BIG ENOUGH FOR YOUR LARGE ORDERS
BIG ENOUGH FOR YOUR SMALL ORDERS

regardless of the size of the piece or the quantity.

G. O. CARLSON, INC.

Stainless Steels Exclusively

New Materials and Equipment



This 25,000 lb hydraulic tilting type melting pot furnace is used for Kirksite metal.

return stroke is double control; (1) a cam flow adjustment to allow a limited rapid return to stop the pouring of the metal; (2) a flow control to permit remainder of return stroke to cushion furnace into return position. A lever handle control valve is mounted on the side of the furnace structure convenient for the operator to observe the pouring of the metal while operating the furnace.

The metal is heated by means of burners mounted below the pot, firing tangentially to the internal lining. This is said to give uniform heat distribution and avoid flame impingment on the pot, contributing to longer pot life.

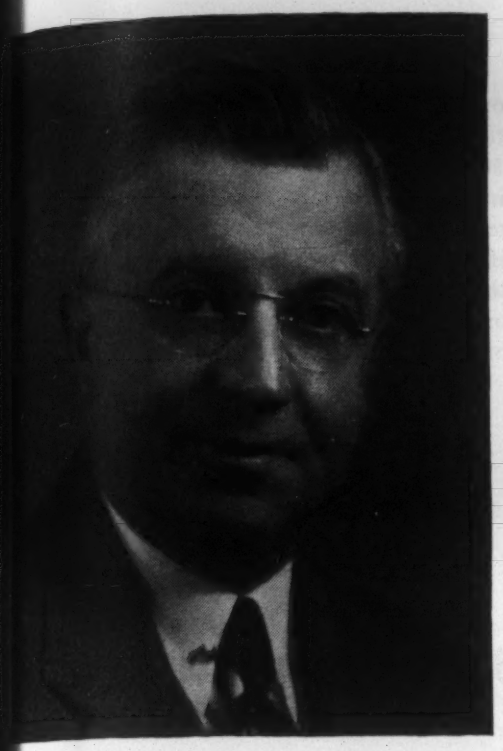
The unit can be built for gas, oil or gas-oil combination firing. Venting out the hot gases takes place between the pot and the refractory ring at the top of the furnace. The large capacity allows a single pour to fill a complete mold, thus eliminating subsequent pours, extra labor and handling costs. The large diameter of the pot opening allows charging of large pieces of metal to be remelted. Pot size is 76 in. in dia. by 32 in. in depth.

Low Temperature Brazing Flux for Titanium

Handy & Harman, 82 Fulton St., New York 38, has announced the development of a special brazing flux for use in the joining of titanium and zirconium and their alloys. Although titanium and zirconium form brittle compounds with most metals and alloys that may be used for brazing, the embrittlement is said to be minimized by rapid heating and limiting the time at brazing temperature. For this reason, low temperature brazing alloys such as Easy-Flo are preferred.

The lower temperature also minimizes

Men who design, engineer and buy America's products rely on..and use..National Laminated Plastics because..



"In long range planning at National, emphasis is placed on engineering research. Designed to benefit National's customers and the entire industry as well, the operation breaks down into three broad divisions. *First*, testing materials against our standards and customers' specifications. *Second*, developing new products to meet specific customer requirements. *Third*, improving present manufacturing methods. In short we at National feel that engineering research provides our eyes and ears for the future."

John K. Johnston
Vice President
National Vulcanized Fibre Co.

Circuit Breaker Bushing Sleuth

George Holton, electrical scientist in National's lab, is testing a Phenolite circuit breaker bushing for dissipation factor at 60 cycles. Tests of this character are constantly carried on for production control and in the development of new products.

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NATIONAL VULCANIZED FIBRE

A tough horn-like material with high dielectric and mechanical strength. Excellent machinability and forming qualities, great resistance to wear and abrasion, long life, lightweight. Sheets, Rods, Tubes, Special Shapes.

PHENOLITE Laminated PLASTIC

Phenolite possesses an unusual combination of properties—a good electrical insulator, great mechanical strength, high resistance to moisture; ready machinability, lightweight. Sheets, Rods, Tubes, Special Shapes.

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Hardness gets its full measure

Important in the production control and development of Phenolite and National Vulcanized Fibre is the degree of punchability of stock for meeting particular customers' specifications. This laboratory research operation with the Rockwell Hardness Tester is shown above.

Phenolite Varsity 1952

Here's the team of skilled scientists, captained by Gerald H. Mains, who occupy key positions at the Phenolite laboratory. They're evidence of National's continuing research program. Their combined know-how is quickly available to National's customers.

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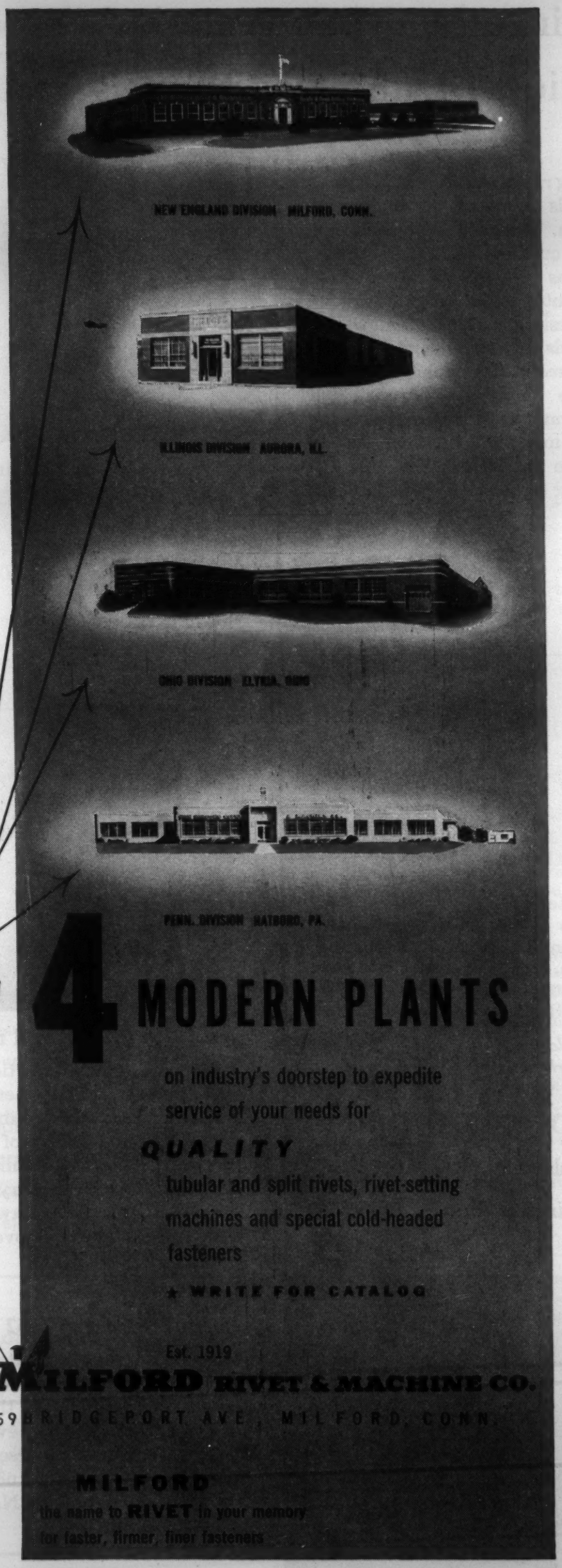


New Materials and Equipment

oxygen and nitrogen contamination of the titanium. Tensile strengths of 45,000 to 50,000 psi are obtained with butt joints in commercially pure titanium. Lap joint test specimens may break outside the joint if the lap is more than three times the thickness. Heating can be done with either oxyacetylene torch or furnace; ordinary brazing technique is used.

Bonder, Leak Sealer and Adhesive Resists Corrosion

The Allen Products Corp., Detroit, has announced the development of Seal-All, a new formulation that is said to adhere to any material, toughen with age, and never become brittle. The new product according to company reports, bonds wood, metal, glass, rubber, fabric and plastic quickly and permanently.

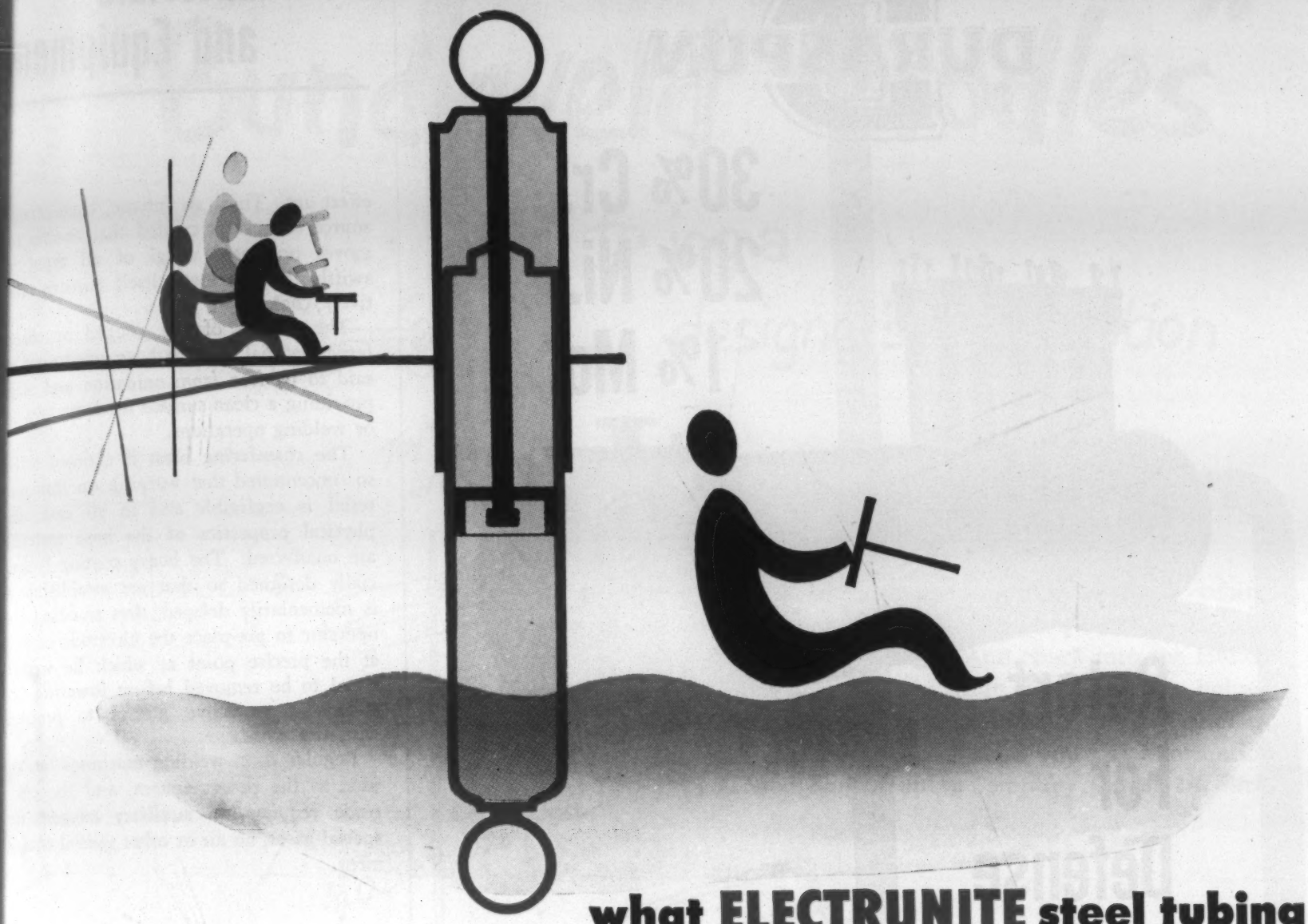
Seal-All is not affected by gasoline, oil, naphtha, alcohol or water, and is claimed to seal leaks effectively in all types of containers, rigid and flexible lines, etc; permanently repair cracked battery cases and distributor caps; insulate and waterproof electric wiring and ignition systems. The product has also been used successfully to impregnate castings for prevention of leaks.

Electrode Gouges and Chamfers Steels

A new, specially formulated electrode for gouging, chamfering, cleaning and partial milling operations on any metal or alloy has been announced by *Eutectic Welding Alloys Corp.*, 40-40 172nd St., Flushing, N. Y. According to the company, the new product effects important time savings as it speeds up fabricating on armor plate and similar difficult-to-weld alloys. Added features include the use of the electrode as a short cut to faster machining operations, since it is said to remove unwanted metal in a flash.

ChamferTrode features a heavy coating which forms a cone at the striking end of the electrode, providing a natural jet

another case where welded steel tubing does the job best . . .



what ELECTRUNITE steel tubing did for shock absorber manufacturers

it can do for you . . .

Today's airplane-type automobile shock absorbers are high-precision devices. They give years of service with practically no maintenance or attention. What's more, they cost . . . and weigh . . . much less than the old-style shock-absorbers that required new webbing or new springs or replacement all too often.

Today's hydraulic shock absorbers use large quantities of ELECTRUNITE Steel Tubing . . . the welded steel tubing that provides plenty of surplus strength to stand rough service under severe loads for many types of devices.

The extremely close ID and OD tolerances of ELECTRUNITE Steel Tubing enable manufacturers to use it without expensive preliminary reaming or finishing. Surfaces are clean, concentric, free from defects. It's produced in carbon, alloy, and stainless grades, in a wide range of sizes, wall thicknesses, and lengths.

If you'd like more information about how ELECTRUNITE Steel Tubing is helping a wide variety of manufacturers and products, write to:

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Made by the producers of
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The "*Original*" ELECTRIC-WELDED BOILER TUBE

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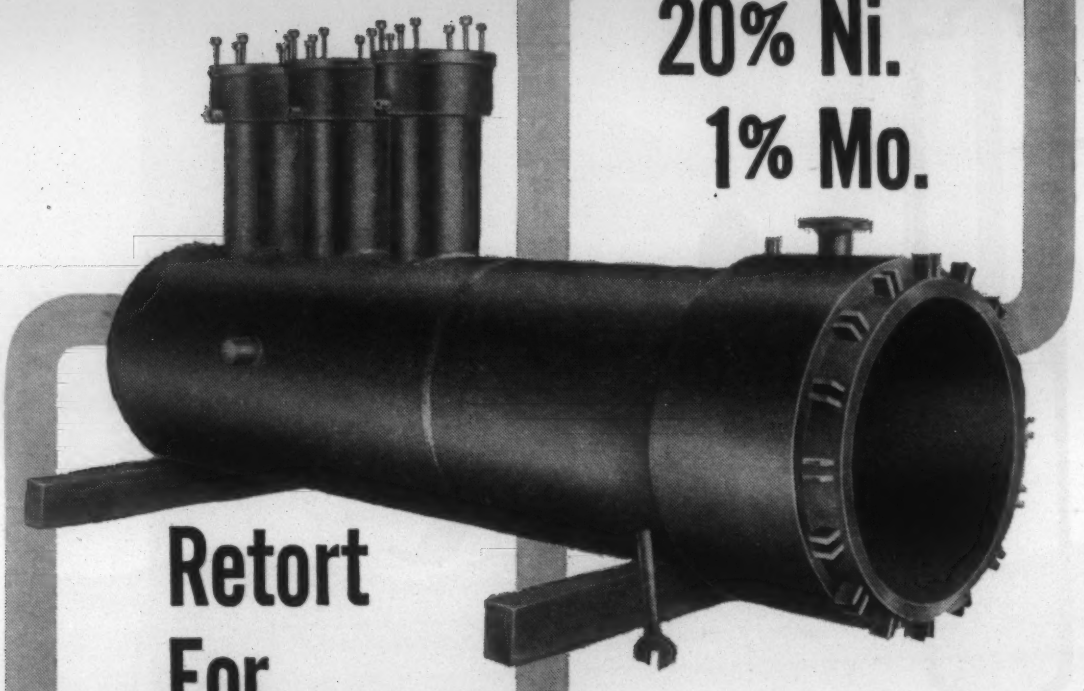
30% Cr.
20% Ni.
1% Mo.



Retort For Defense Project

Perhaps the most interesting feature of this Duraspun High Alloy Casting is that four different sizes of centrifugal castings are involved. These vary from 34" to 3½" in diameter. Sections, outlets, collar bands, lugs etc., were all welded together in our shop to form the retort as you see it in the picture. Assembled weight runs around 7,464 pounds.

High alloy castings is our business—not merely the adjunct of an extensive steel founding business. We have the experience — 30 years in the static casting division and 20 years on centrifugal castings. We pioneered both kinds of castings in this country. And we have excellent testing and checking facilities, including a 400,000 volt X-ray machine and gamma-ray units.

If you would like this combination of wide experience, modern shop practice, up-to-date equipment and full testing facilities working on your next high alloy casting, bring it to us.

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New Materials and Equipment

effect arc. Thus, an intense, concentrated source of heat is created that readily removes unwanted metal of all types so swiftly that the metal itself remains relatively cool.

The surface of the gouged or chamfered material that has been acted upon is said to be free from oxidation and slag, providing a clean surface for later brazing or welding operations.

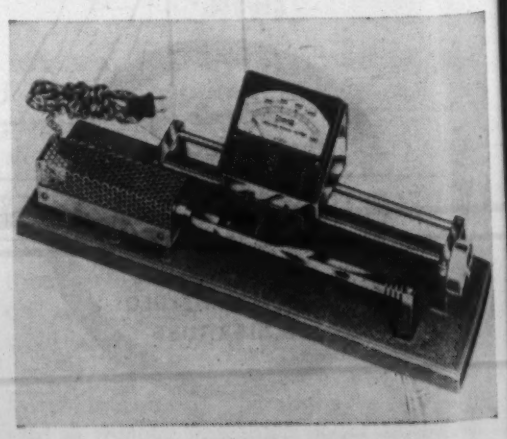
The chamfering blast is claimed to be so concentrated that warping on thin material is negligible and in all cases the physical properties of the base material are unaffected. The heavy coating is specially designed so that arc establishment is momentarily delayed, thus enabling the operator to pre-place the electrode exactly at the precise point at which he wishes metal to be removed before lowering his shield or protective glasses to proceed with the work.

Regular d. c. welding machines can be used as the power source, and the electrode requires no auxiliary oxygen, no special gases, no air or other special equipment.

Melting Point Meter Determines Melting Points Between 20 and 500 F

Accurate determinations of melting points can be made with quantities of but a few milligrams through the use of the Model 304 Clarkstan Melting Point Meter currently offered by *Clarkstan Corp.*, Los Angeles 64. With reasonable precautions, samples can be recovered uncontaminated.

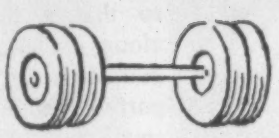
The method is a quick one. A small quantity of the substance (wax, resins,



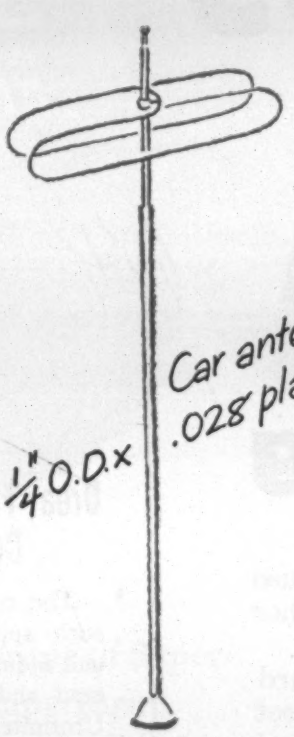
Accurate determination of melting points can be made with this new melting point meter.

Bundyweld "Doodles"

to jog a designer's imagination

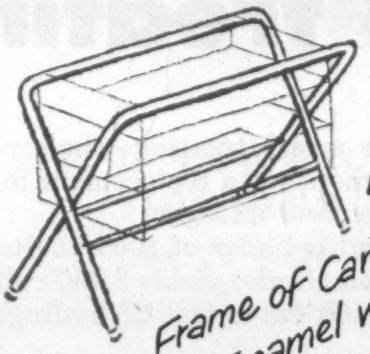


Toy truck axles ✓

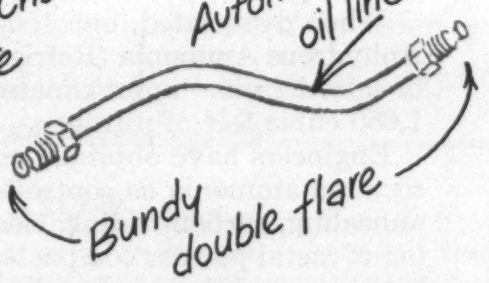


Car antenna .028 plated

1¼" O.D. x



Frame of Carry-Crib Enamel white



Automobile oil line

Bundy double flare

Redesigning to get better tubing function? Want smoother, easier fabrication? Need engineering help to crack tough tubing problems?

Then check into Bundyweld, the *only* tubing double-walled from a single strip, with inside and outside beveled edges. And check into the Bundy engineering services that have already helped hundreds of Bundy customers to save money, time, materials. Let us send you the information you need. ***Bundy Tubing Company, Detroit 14, Mich.***

Bundyweld® Tubing

DOUBLE-WALLED FROM A SINGLE STRIP

High thermal conductivity
High bursting point
Leakproof
High endurance limit
Extra-strong
Shock-resistant
Ductile

Lightweight
Machines easily
Takes plastic coating
Scale-free
Bright and clean
No inside bead
Uniform I.D., O.D.

WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness, and

passed through a furnace. Copper coating fuses with steel. Presto . . .

Bundyweld, double-walled and brazed through 360° of wall contact.

←

NOTE the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

Bundy Tubing Distributors and Representatives: ***Cambridge, 42, Mass.:*** Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Philadelphia 3, Penn.:*** Rutan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave. South ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 881 Bay St. • **Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.**

ASK BARRETT

for information on

DISSOCIATED ANHYDROUS AMMONIA

for metal treating

You effect real economies in metal treating when you use Barrett* Standard Anhydrous Ammonia as a replacement for other more expensive sources of hydrogen and nitrogen.

When dissociated, one 150-pound cylinder of Barrett Standard Anhydrous Ammonia (Refrigeration Grade) yields 6,750 cubic feet of mixed gases—approximately 5,100 cubic feet of hydrogen and 1,650 cubic feet of nitrogen.

Engineers have obtained many advantages from the use of dissociated ammonia as controlled atmosphere in furnaces for bright annealing, carbonitriding, clean hardening, copper brazing, sintering of metal powder compacts, reduction of metallic oxides, atomic hydrogen welding, and radio tube firing and sealing. Anhydrous ammonia also has unsurpassed qualities in the nitriding of steel, used as ammonia gas or dissociated.

The advice and assistance of Barrett technical men are readily available. For information, contact Barrett, *America's leading distributor of ammonia.*

Barrett Standard Anhydrous Ammonia

In 150, 100 and 50-pound cylinders for fast delivery from a stock point located near you. And in tank car shipments from Hopewell, Va., and South Point, Ohio.

THE BARRETT DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 RECTOR STREET, NEW YORK 6, N. Y.

America's Leading Distributor of AMMONIA

Barrett*

*Reg. U. S. Pat. Off.

New Materials and Equipment

gums, fats, tars, plastics, low melting alloys, organic compounds, inorganic compounds) is placed on a chromium-plated platen or bar which is electrically heated so that a temperature gradient obtains along its length. By observation, the demarcation between the molten and solid particles is determined. At this point the small thermocouple junction is placed, and within a few seconds, the easily-read meter indicates the temperature of the point chosen. A screw feed allows the operator to follow the melting point as the bar temperature changes.

Both platen and thermocouple are easily removed for cleaning and for change in case of damage or contamination. Any one of the four sides of the platen can be used. The instrument operates on 110-v a.c. or d.c.

Urea Formaldehyde Resin Lowers Cost of Baking Enamels

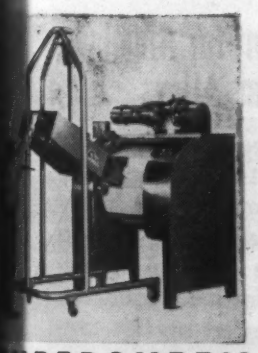
The cost of white baking enamels for such applications as coatings for home and industrial equipment can now be lowered and stabilized through the use of Uformite F-158, a new urea formaldehyde resin recently announced by *Rohm & Haas Co.,* Washington Sq., Philadelphia. The resin is based on propyl alcohol, which should be less subject to wide price fluctuations than the more widely used butanol.

Uformite F-158 compares favorably with the company's long established Uformite F-200E. When employed as the amine component of white industrial baking enamels, it is said to provide: fast-baking speed with good hardness; excellent gloss and gloss retention; excellent color and color retention; excellent stability; good adhesion; and high resistance to water.

Steel Locknuts Good for Temperatures Up to 550 F

Standard Pressed Steel Co., Box 888, Jenkintown, Pa., has announced the availability of commercial Flexloc locknuts which can be used continuously in temperatures as high as 550 F. Because these

FREE!



SUPERSHEEN MODEL DB-200

An example of Supersheen superiority. This advanced design barrel handles micro-finishing of small precision parts with same ease of fast cutting down of larger castings, forgings, etc.

Why worry about man power shortages and high-cost labor? These two BIG PROBLEMS are now being solved by large and small manufacturers with Supersheen Advanced Barrel Finishing Equipment. *A SINGLE UNIT INSTALLATION REPLACES FROM 2 TO 12 MEN;* savings run as much as 95% under former finishing methods. Mail coupon at right for complete information.

FREE SAMPLE PROCESSING

ALMCO Supersheen

AMERICA'S LARGEST MANUFACTURER OF ADVANCED BARREL FINISHING EQUIPMENT—MATERIALS AND COMPOUNDS
ALBERT LEA, MINNESOTA

1. IF YOU PRODUCE PARTS THAT REQUIRE FINISHING OF ANY KIND . . .
this 22 page booklet is *guaranteed* to open your eyes! It gives you the inside story of advanced barrel finishing *as never told before!*

2. COMPLETE CATALOG . . .
of America's most complete line of advanced barrel finishing equipment. *All types!* Barrel sizes range from 8"x16" to 30"x60". *All-Mechanical* loading and unloading equipment, separating and storage equipment, etc. *For large and small plants.*

3. FOR THE FINEST FINISH EVER . . .
Almco Supersheen Abrasive Chips and "Concentrated" Compounds. For *any and all* types of barrel finishing! Catalog gives specific data on the industry's *most complete line* of barrel finishing materials.

ALMCO SUPERSHEEN F-4 Albert Lea, Minnesota

Send me the above 3 catalogs at once.

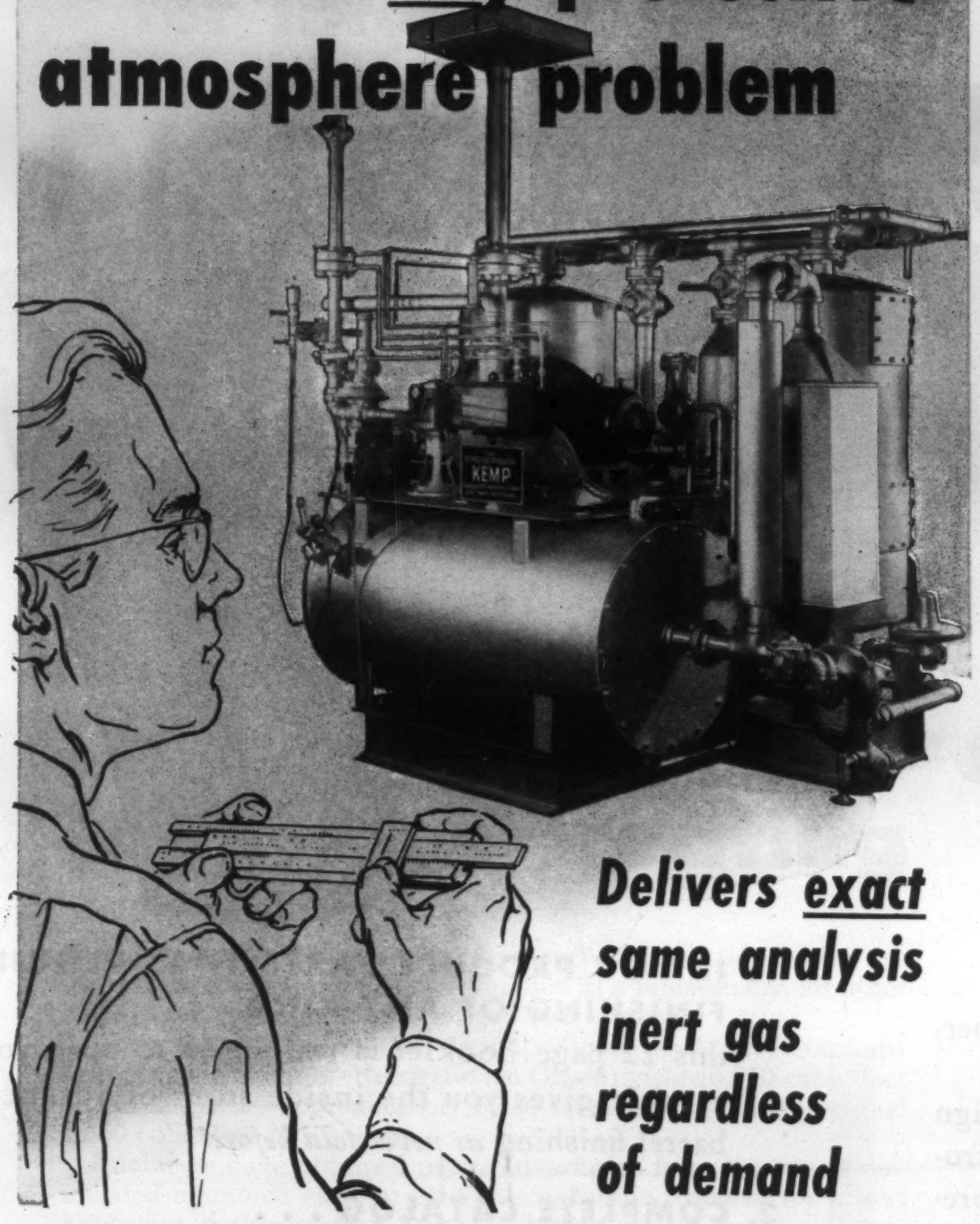
MAIL COUPON NOW!

NAME _____

ADDRESS _____

CITY _____ STATE _____

You can count on KEMP to solve any protective atmosphere problem



Delivers exact same analysis inert gas regardless of demand

DAY AFTER DAY Kemp users throughout the metals field report: Kemp Atmosphere Gas Generators *maintain* exact analysis of chemically clean atmosphere gas *regardless* of demand . . . *eliminate* the possibility of mixture fluctuations at some critical phase of processing. These same users report big gas and maintenance savings with Kemp. Also Kemp Generators are fast-starting, easy-to-operate . . . offer real savings in both *time* and *money* by reducing the costly warm-up period necessary for starting. You can't go wrong when you specify Kemp Atmosphere Gas Generators.

Set it . . . forget it!

The Kemp Industrial Carburetor, standard equipment and the very heart of every Kemp installation, assures you complete combustion . . . without tinkering . . . without waste. Uses ordinary gas right from mains. Every Kemp Design includes complete up-to-the-minute fire checks and safety devices. Why not find out how Kemp can help you with your problems, today?

KEMP OF BALTIMORE

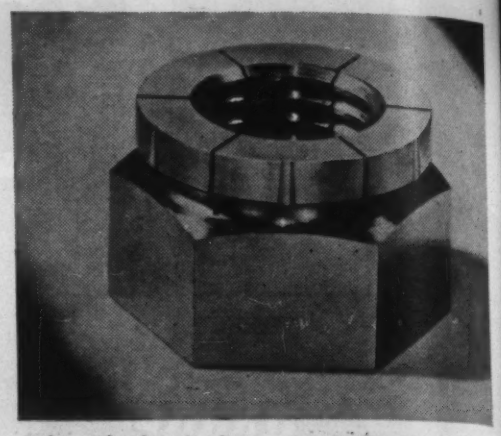
GAS GENERATORS

Write for Bulletin I-10 for technical information

THE C. M. KEMP MFG. CO.
405 E. Oliver Street, Baltimore 2, Md.

CARBURETORS • BURNERS • FIRE CHECKS • ATMOSPHERE & INERT GAS GENERATORS
ADSORPTIVE DRYERS • METAL MELTING UNITS • SINGEING EQUIPMENT • SPECIAL EQUIPMENT

New Materials and Equipment



This Flexloc locknut can be used at temperatures as high as 550 F.

locknuts are made entirely of steel, their locking efficiency is not impaired by high temperatures.

The top of the nut is slotted into six flexible segments. When the nut is run on a bolt or other threaded member, the segments grip the threads with an action similar to that of the jaws of a chuck. Locking torques are closely controlled by precision manufacture.

Conversion Treatment for Aluminum and Aluminum Alloys

The Silver Star Chemical Corp., 58 Watts St., New York 13, has announced the development of a new and better conversion treatment for aluminum and its alloys. Starcote, as the material is designated, is said to afford superior corrosion resistance and perfect organic coating adherence.

Inexpensive and easy to use, the Starcote bath is maintained by a simple titration. Work can be handled in iron containers or racked. The material can be applied by dipping or by a conventional alkaline washing machine on a production line basis.

Hot Spray Lacquers Offer Many Advantages

Development of hot spray lacquers in a wide variety of colors has been anonunced by *Monroe Sander Corp.*, Long Island City, N. Y. Company officials point out that in hot lacquers, heat used as a viscos-

Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

Omega Tool Steel Outpunches Two Air-Hardening Grades

Our Omega tool steel took on two different air-hardening grades and outpunched them to win a unanimous decision. It all came about when one of our customers began the production of steel posts to be used for barbed wire entanglements by our armed forces. Made from re-rolled steel rails, the posts had to have several holes punched in them. We were asked to suggest a tool steel for this tough, cold-punching work.

It looked to us like a job for Omega, our silico-manganese grade that's tops for cold-battering and heavy shock work. The customer made up some punches from Omega and also some from two different air-hardening steels.

The production trial gave the customer a clear-cut result. The punches made from the air-hardening tool steels broke in less than eight hours. Those made from Omega needed only slight redressing after eight hours . . . in which time some 4000 posts were punched. Since then the Omega punches have stood up even better than the customer expected, saving steel and precious time.

There's nothing spectacular about this report. But it does illustrate the importance of starting with the right steel for the job.

Bethlehem tool steel specialists have the experience to help you get the most out of your tool steel, whether it's a problem of selection, tool design, machining, heat-treatment, or grinding.

Our Tool Steel Engineer Says:

Tool Steel Preheating Is Good Insurance

Steels having a hardening temperature above 1650 F should first be preheated at about 1200 to 1300 F. This shortens the heating time at the hardening temperature, helps to reduce excessive scaling and decarburization which occur rapidly at high temperatures.

Steels hardened above 2000 F should be preheated at about 1600 F.

8 TOOL STEELS for 90 PER CENT of ALL TOOL and DIE WORK

Reducing the number of tool steels you carry in stock simplifies tool room problems. It makes heat-treating easier and leads to lower costs.

Just eight mighty fine tool steels will handle 90 pct of all tool and die jobs:

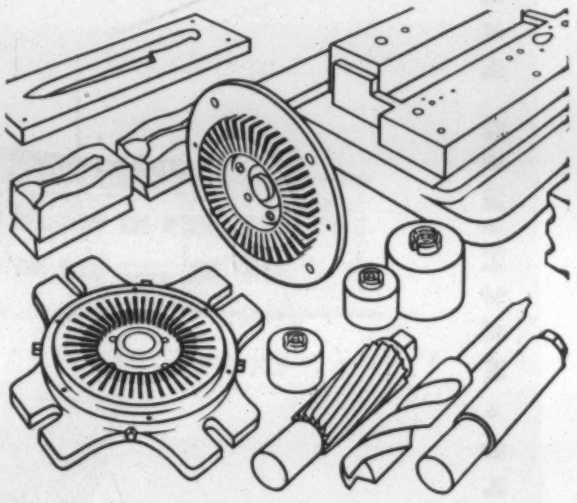
CARBON AND CARBON-VANADIUM For general-purpose tools. Water-hardening, it produces a tough core and a hard, wear-resisting case. Easiest to machine and heat-treat.

BTR Oil-hardening steel of the manganese-chromium-tungsten-vanadium type. For more intricate tools requiring safer hardening and less distortion.

A-H5 Our 5 pct chrome, air-hardening grade for greater protection against cracking . . . and for less distortion and better wear-resistance than BTR.

LEHIGH H High-carbon, high-chromium steel. An air-hardening grade, it's first choice wherever maximum wear and minimum distortion are important.

OMEGA For cold-battering tools. This silico-manganese steel combines hardness with maximum toughness for severe shock jobs on cold work.

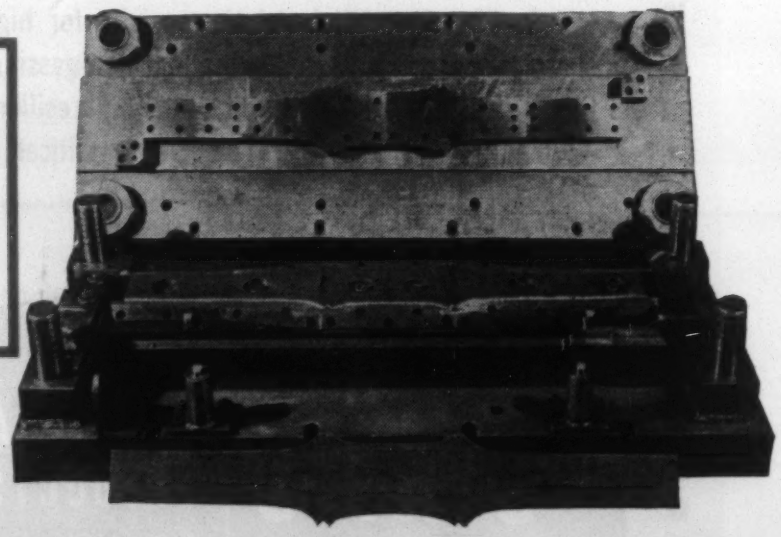


67 CHISEL Our chromium-tungsten grade for various shock tools and master hobs. When carburized for extra wear-resistance, it retains a hard, tough core.

CR-MO-W This 5-pct-chromium hot-work steel is ideal for jobs involving shock, drastic temperature changes, and where heat-checking is a problem.

66HS Today's most popular type of high-speed steel, this tungsten-moly grade is ideal for nearly all cutting tools. It's the AISI M2 type.

Big Blanks for Axle Housings



This die blanks out rear-axle housings from 3/16-in. sheet steel—3000 to 4000 per shift. Hardened to Rockwell C-61, the die needs only slight redressing after producing 50,000 pieces. Lehigh H, our air-hardening grade of high-carbon, high-chrome steel, is used because of its high wear-resistance and minimum distortion in heat-treatment. It's deep-hardening, ideal for heavy-duty dies.

Bethlehem ULTRASONIC TESTED **Tool Steel**

SHEETS • RODS • TUBING • BARS • CYLINDERS • TAPE • MACHINED PARTS • MOLDED PARTS

FIRST
IN FABRICATING "KNOW-HOW"
TEFLON*---- KEL-F
And the Most Modern Facilities for Rapid,
Low-Cost, Close-Tolerance Production

The United States Gasket Company began fabricating TEFLON, years ago when it was first offered commercially, and has pioneered its application to countless purposes throughout industry. You profit from this unusual experience and "Know-How," when you specify "TEFLON or KEL-F—fabricated by the United States Gasket Co."

You can be sure of uniform high quality, accuracy of dimensions, prompt attention to your requirements whether on stock (the most complete line in the country), or on custom machined or molded parts.

Get the advantages of these fluorocarbon plastics—fabricated by U.S.G. The finest dielectrics especially for high frequency service, chemically inert, non-contaminating, non-gassing, zero water absorption, unaffected by humidity, tough, resilient, serviceable from −110°F. to 500°F. without change in critical electrical or physical characteristics. Write for Bulletin No. 300.

*duPont's trademark for its tetrafluoroethylene resin

UNITED STATES GASKET COMPANY
FLUOROCARBON PRODUCTS DIVISION
FABRICATORS OF "TEFLON", "KEL-F" AND OTHER FLUOROCARBON PLASTICS
CAMDEN 1 NEW JERSEY

New Materials and Equipment

ity reducing agent makes thinners unnecessary, thereby eliminating one cost factor. But aside from this, the finishes have many other advantages.

Because of the heat, the finishes are adjusted to give the right viscosity; uniformity is assured at all times; less coats of hot spray lacquers are required than conventional lacquers; coverage is increased per gallon; and blushing of lacquer on humid days is overcome due to the controlled temperature.

According to the company, repeated "cold tests" on the new lacquers show that these finishes are crack resistant after they are applied to furniture and other wood products.

Hard-Facing Electrodes and Rods for a Wide Range of Applications

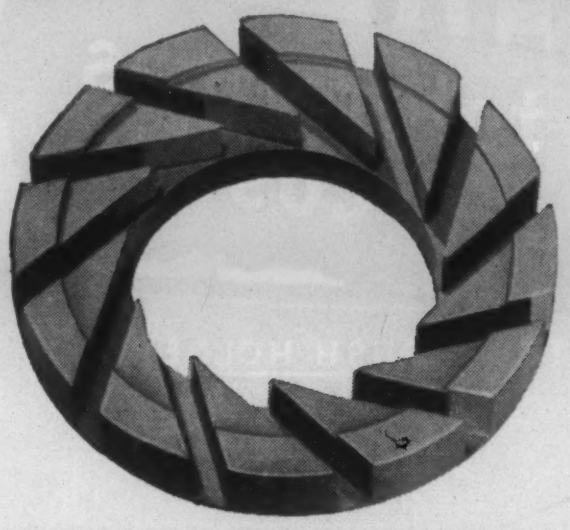
A new line of hard-facing electrodes and acetylene welding rods has been announced by *Metal & Thermit Corp.*, 100 E. 42nd St., New York 17. These include rods for extreme abrasion, medium and heavy impact, severe shock, high red hardness, and extreme heat and corrosion resistance. In addition, there is a new Murex tungsten-carbide rod which provides an exceptionally slag-free deposit, allowing all residue to be readily cleaned away by wire brushing.

Fully field-tested and already in use on a wide variety of hard-facing applications, the new products are expected to become more and more important as basic materials become tighter in supply.

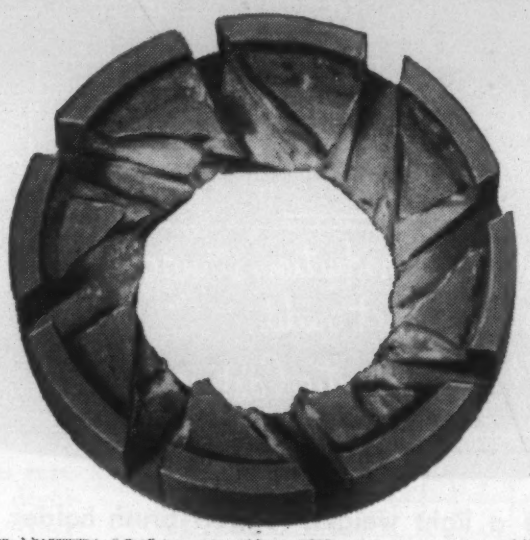
Noncorrosive Acid Surface Conditioner for Finished Ferrous Metal Parts

Nielco Laboratories, Detroit, has announced the development of a new corrosion control acid surface conditioner for finished ferrous metal parts, such as stampings, machined steel parts, shaftings, pistons, valves, tappets and castings, including Meehanite, prior to assembling, painting or plating. Ferr-O-Niel 985 is a

This HAYNES STELLITE alloy part *lasted 12 times as long as* this alloy steel part



AFTER
1 YEAR'S
SERVICE



AFTER
30 DAYS'
SERVICE

Micronizer nozzle disks, machined from alloy steel, wore out in just 30 days when used for converting gas house tar into an ignited vapor in a steam generator unit. The abrasive particles in the fuel and the high velocity (39,000 ft. per min.) of the steam rapidly eroded the alloy steel parts to destruction. This same limited service was obtained from disks used in precipitating dust from the exhaust uptake of air-swept coal pulverizers in a power plant.

After considerable testing, investment-cast parts of HAYNES STELLITE alloy No. 19 were adopted as standard equipment. This hard cobalt-base alloy stands up for at least a year under the severe abrasion—outwears the alloy steel 12 to 1. The parts are produced so accurately by the investment casting process that finishing operations are cut to a minimum.

HAYNES precision casting is an ideal manufacturing method for parts that must be made from an alloy difficult to fabricate into intricate shapes by ordinary methods. For more information, write for the booklet, "Investment Castings."

HAYNES TRADE-MARK *alloys*

Haynes Stellite Company
A Division of
Union Carbide and Carbon Corporation
UCC
General Offices and Works, Kokomo, Indiana
Sales Offices
Chicago — Cleveland — Detroit — Houston
Los Angeles — New York — San Francisco — Tulsa

"Haynes" and "Haynes Stellite" are trade-marks of Union Carbide and Carbon Corporation.

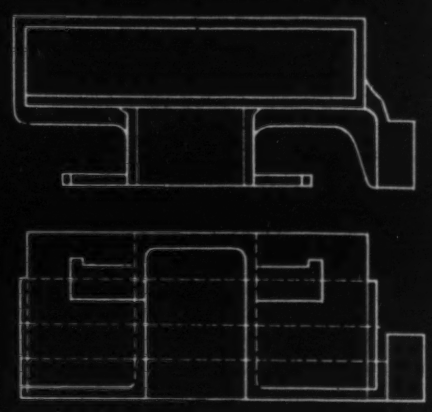
WANTED: closer tolerances reduced costs

SUGGESTED - BRUSH HOLDER

General Electric Co.,
Small Motors Division,
Lynn, Mass.

Att: DESIGN ENGINEERING

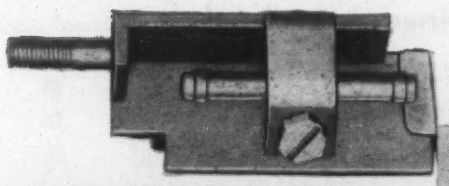
.076 MIN. WALL



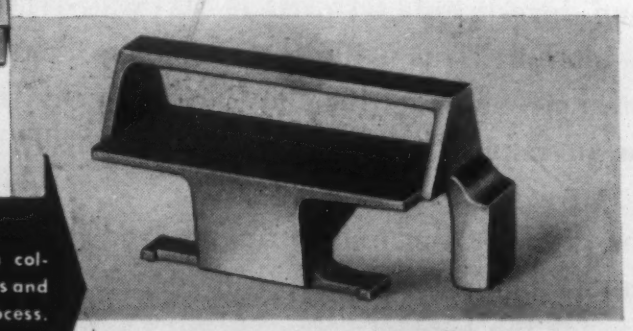
This design is the best from production standpoint
We could produce it to reflect credit
on both companies. E.B. Atlantic Casting

The production of a light weight, rugged brush holder for use with aircraft generators posed a problem for General Electric. They wanted a high-quality, rigid brush holder at reduced cost, produced by a process that afforded closer control of tolerances.

Atlantic was consulted and the recommendations they made on the brush holder design provided more than ample strength. The Atlantalloy process provided the close tolerances and lower cost.



Old brush holder designed by General Electric for use on aircraft generators.



New brush holder designed in collaboration with Atlantic engineers and produced by the Plaster Mold Process.

WRITE for a copy of "Quality Precision Castings for Industry" on your Company letterhead. This booklet explains how the plaster mold process cuts production costs, and includes specifications on Atlantic's alloys.

CASTING and ENGINEERING CORP.

New Materials and Equipment

carefully balanced noncorrosive acid surface conditioner built from a phosphoric acid base, so formulated as to do a complete job of removing light oil, soil, normal oxides and smutt without in any way changing the tolerances of the metal or building up hydrogen embrittlement.

The new surface conditioner should be used at a concentration of 1 part to 3 parts of water and should be heated to an operating temperature of not less than 180 F. The cycle of operation when processing stampings and machined parts free of heavy corrosion is 3 min; where more than a flash of rust is present, sufficient time should be given to assure its complete removal. Meehanite castings should also be given a 3-min immersion, but gray iron castings prior to plating, particularly zinc plating, should be given 5 min.

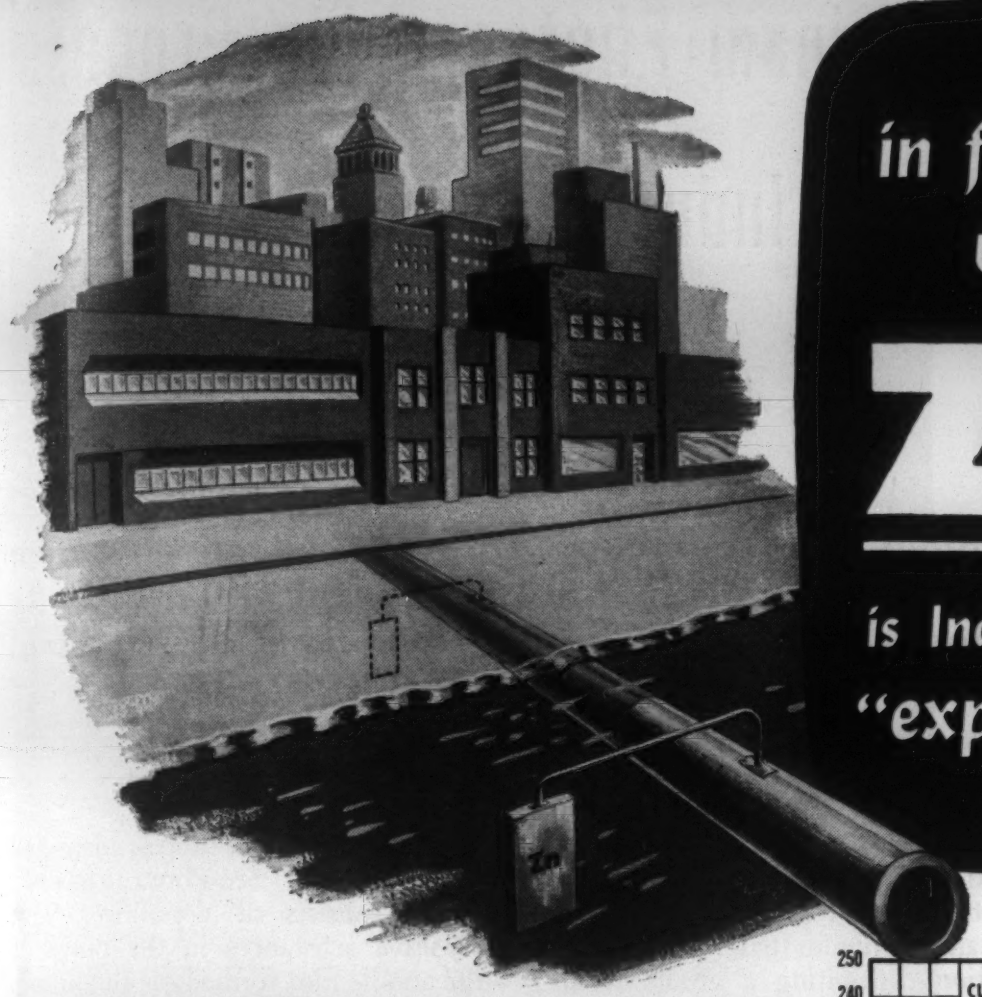
According to the manufacturer, Ferr-O-Niel 985 will remove brazing and welding oxides, but will not remove oxides from heat treated metal where temperature has exceeded 1300 F. All smutt from stampings, machined parts and castings will be removed. The solution will not attack the brass or copper that may be part of any stampings processed in the solution. It will remove the oxide and otherwise clean up the nonferrous metal.

Strippable Plastic Finish Has Many Uses

Development of a versatile plastic strip finish, VC-12, that is said to provide excellent protection against corrosion, the weather and abrasion, and when desired, can be peeled off easily, has been announced by *United Lacquer Manufacturing Corp.*, 1001 W. Elizabeth Ave., Linden, N. J. The new vinyl finish can be used on all metal surfaces and on wood, and is claimed to be especially useful for the following purposes:

1. For temporary masking of objects during manufacturing operations, as in the automobile and appliance industries.
2. For lining paint spray booths in factories.
3. For protection of the thin chromium plating on automobiles while in transport.
4. For protective purposes in metal etching operations.
5. For coating fine novelty jewelry.

The new finish can be applied by brush or spray and sets to touch in 15 min. It dries to packing hardness overnight, and is available in clear and tinted clears.



in fighting corrosion with corrosion—

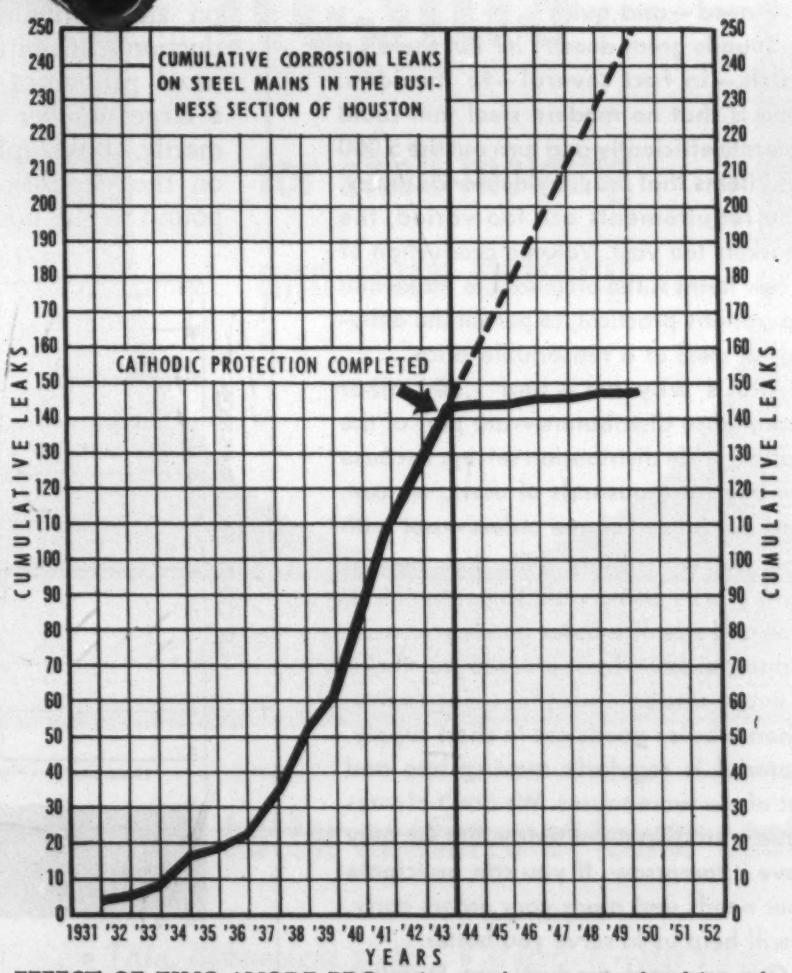
ZINC

is Industry's most effective "expendable" weapon!

NEARLY 50% of all the zinc consumed annually in the United States — around 400,000 tons — is used in galvanizing, i.e., protective zinc coating on iron or steel. This is ample evidence of the firmly established position of the metal as industry's most effective and economical "sacrificial" weapon in its unceasing combat with rust. The electrochemical reaction between iron and zinc, which has resulted in the dominance of zinc in this field, is precisely the same as that which takes place in the relatively new and growing use of the metal for cathodic protection of pipe lines and other underground iron and steel structures. The sole difference between the two methods being that in cathodic protection the zinc, in the form of anodes, is buried adjacent to a pipe line and connected by a conductor, while in galvanizing the zinc is bonded to iron or steel. In either form, zinc "protects" — as has been attested to by those progressive companies who have used zinc anodes for this purpose. For example, in the Northwest, a utility company reports:

> *"The most interesting installation was made in 1942 on four inch bare pipe located in the seepage from an irrigation ditch that circled the brow of a hill in such a manner that the pipeline trench intersecting the irrigation ditch was kept moist throughout the season. Approximately seven hundred feet of this four inch line had been replaced twice. In the spring of 1942 leakage developed and when the pipe was uncovered it was found to be in bad condition. Pending replacement, repairs were made and seventeen zinc anodes were installed with series-parallel connections. In the press of other work, this replacement job was put aside and in 1943 it was found that no further leaks had developed. In 1948 the replacement had still not been made and we were getting a good potential-to-ground and plenty of protective current. The last test made in the spring of 1950 shows a slight increase in the potential-to-ground and the pipe has not been replaced nor have we felt it even necessary to uncover it for visual inspection."*

The graph at right provides additional evidence from the State of Texas. Here are two examples, under widely dissimilar conditions, where zinc has proved itself as a highly efficient cathodic protector for underground pipe lines. This is not surprising in view of the long-recognized superiority of the metal in the field of galvanizing.



EFFECT OF ZINC ANODE PROTECTION ON OLD LINES. *Most of the United Gas Corp.'s welded-steel-gas distribution mains, coated with hot asphalt and asbestos wrapper, were installed before 1930. Cathodic protection of mains with zinc anodes was completed in early 1944. Curve shows cumulative leak record of these mains. Only 5 corrosion leaks occurred in the 6 years since cathodic protection was applied, comparing with 142 during 1932-1944.*

ST. JOSEPH LEAD COMPANY 250 PARK AVE., N.Y. 17

for Galvanic & Cathodic Protection Zinc is Standard

Zn

ST. JOE Electro-Thermic ZINC: *High grade, Intermediate, Brass special, Prime western*

BUNKER HILL 99.99+ % ZINC

Like to OWN A Steel Mill?

Would you like to own a steel mill—today—and get all the tubes and pipe you need—and quick?

Sounds great doesn't it? But there's a catch,—in fact several—to the idea. One is that no modern steel mill could operate efficiently and turn out the 5,000 odd items that industry demands today. The requirements are too varied, the markets too vast. Volume production of a few items is the only way to make mill operations practical, to permit the delivery of steel at a reasonable price.

That's why we—and 1,500 other warehouse distributors—are part of the nation-wide distribution set-up. Because we buy for thousands of users, we can, and do, place volume orders—not with one, but with many mills. You benefit from this by being able to get the kind, type and size of tubular goods you want—and quickly—from warehouse stocks.

Even under today's stringencies, when tubular goods are in short supply, material is regularly moving into and out of our warehouses. We don't always have what you want today, but we may have it tomorrow. If you can anticipate your needs and place your orders early, it will help us to serve you better.

Our principal products are Stainless Steel Tubing and Pipe, Seamless Mechanical Tubing, Boiler and Pressure Tubes, Seamless Steel Pipe, Carbon and Stainless Steel Fittings. We fabricate pipe and tubing in our own shops.

STEEL TUBULAR PRODUCTS

A B MURRAY CO., INC.

SINCE 1865

ELIZABETH, N. J. McKEESPORT, PA.

Aluminum Photographic Process Has Industrial Applications

by **EUGENE WAINER**, Horizons Inc.

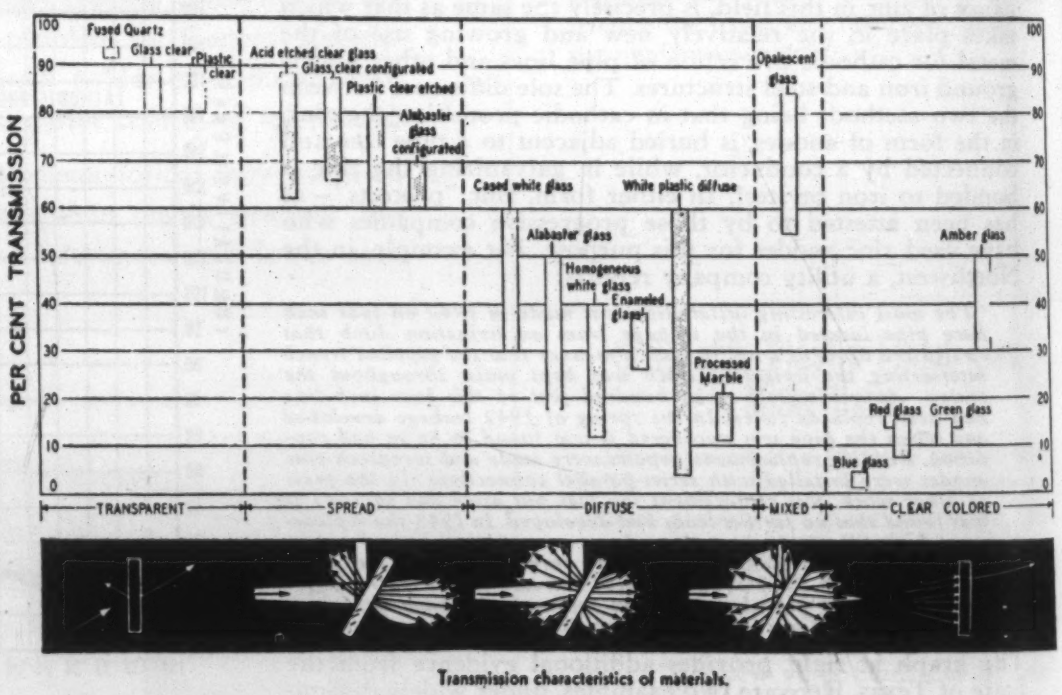
Photographic reproduction directly on an aluminum base offers prints that are permanent and practically indestructible under normal conditions of handling.

● ALUPHOTO IS A recently developed Swiss invention which puts photographic reproductions directly on an aluminum base, such reproductions exhibiting a group of unusual properties and advantages for a large number of applications. Primarily, the Aluphoto process is based on the deposition of a silver compound in the pores of a fibrous compound of aluminum. In this respect it differs radically from current methods of photographing on metals by coating the metal with a gelatin emulsion. This fibrous aluminum compound is formed on the surface of the metal either by electrolysis or by chemical treatments.

The possibility of using such a surface for photographic purposes was first investigated by Siemens and Halske in the early 1930's. Their efforts resulted in a process identified by the name "Seo-Photo Process", which consists of depositing light sensitive substances in the pores of the anodic film formed on aluminum. The primary disadvantage of the Seo-Photo Process was the instability exhibited so that the plates must be exposed within a very short time after preparation and then developed and fixed equally quickly in order to obtain a permanent image.

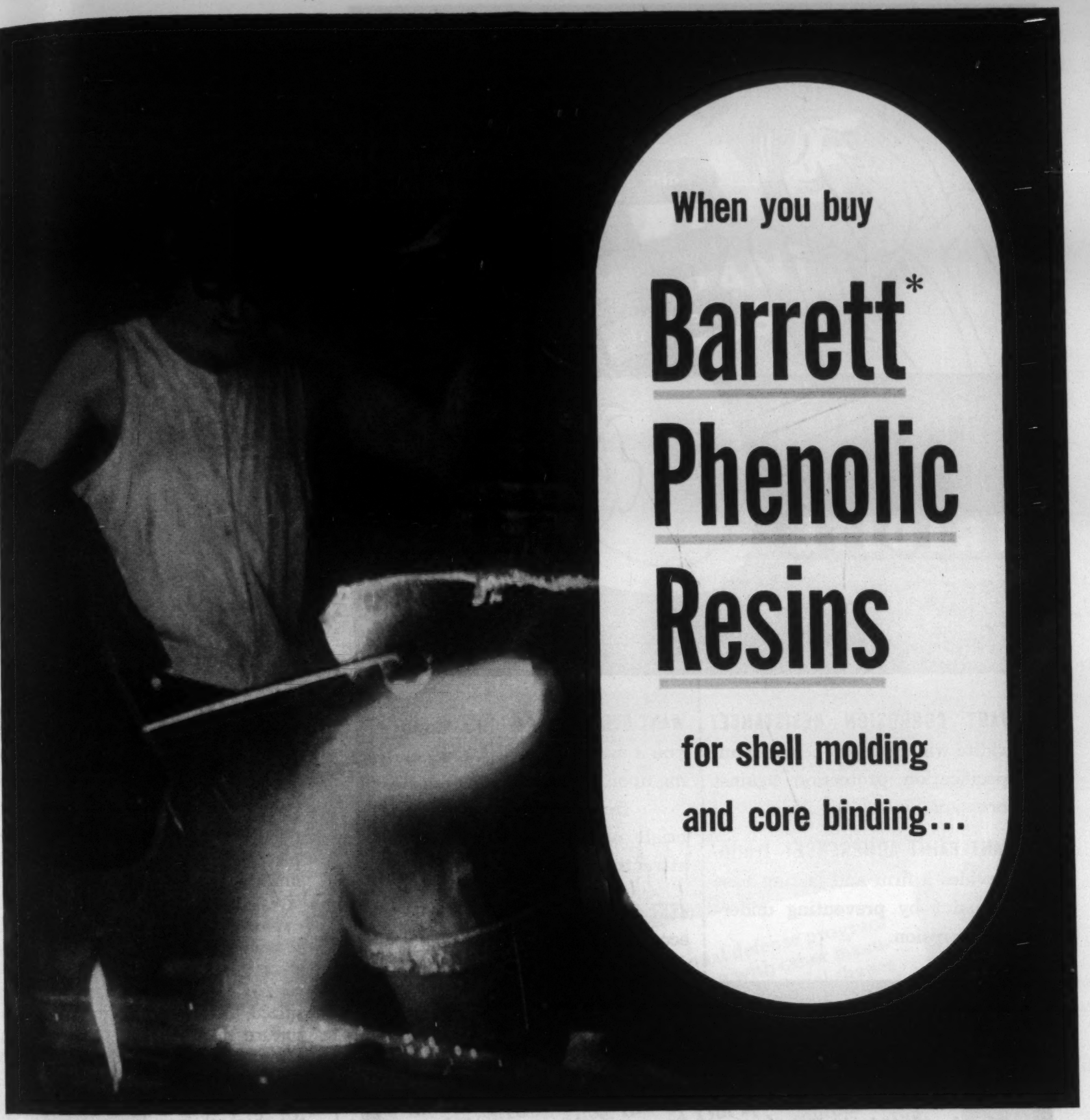
The Aluphoto process, developed by Dr. Mischenk of Basle, Switzerland, exhibits the signal advantage over its progenitor in that the plate containing the photosensitive material in the unsensitized condition can be stocked for years. The primary difference between the Aluphoto

(Continued on page 178)



Transmission characteristics of materials.

Charts reproduced on aluminum have greater permanency than those on paper.



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BEST OF ALL, any Iridite finish is economical and easy to apply.

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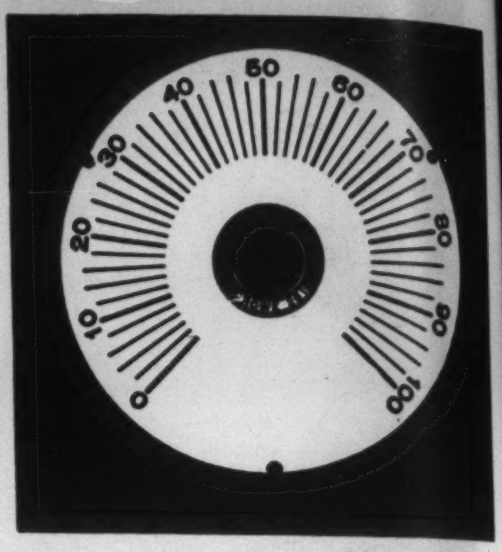
Aluminum Photo Process . . .

Continued from page 176

process and the Seo-Photo Process is that the nature of the impregnation with silver compounds is such that the sensitization may be carried out very simply and easily by the user.



Black or white instrument dials are prepared with equal ease.

Even in the sensitized condition, the plates are stable for periods of at least two to three months. The plate is permanently stable after the image is formed.

The Aluphoto plate, then, is a photosensitive anodized aluminum plate in which the photographic image is developed in the anodized layer. The plates are sensitized and exposed by the user, and for this reason may be shipped and handled with impunity in the pre-sensitized state. Once the plate has been sensitized, exposed and developed, the surface may be heat sealed and, as a result, becomes hard and glass-like in character. If desired, the surface can be buffed on a wheel to develop the highest possible gloss on the plate.

Advantages

The properties of the plate which make the process attractive may be listed as follows:

1. The simplicity of handling.
2. The resistance to destruction or deterioration under a variety of conditions, such as immersion in water, boiling water, salt spray, salt water, weather, light. It is heat resistant up to at least 1100 F, has good scratch resistance, is unaffected by hot oils, fats, organic solvents, and is unaffected by contact with food stuffs and food acids. The heat resistance is an unusual characteristic in that

(Continued on page 180)

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TRADE MARK

CORROSION-RESISTANT WELDING FITTINGS

Reducers, stub ends, and caps are standard items of FLOWLINE corrosion-resistant pipe welding fittings. They are formed cold, seamless, by our exclusive process that puts the metal in the best condition for corrosion resistance. These fittings are made and normally stocked in various schedules—in sizes ½″ through 12″—in Stainless Steel Types 304, 316, and 347; Monel, Nickel, and Inconel. Other corrosion-resistant metals can also be supplied.

During the national defense program we are cooperating with other manufacturers by producing special shapes in corrosion-resistant metals. The sections of cylindrical shapes shown on the background are representative. In many instances available dies can be used. Our specialized production facilities include equipment for cold forming, annealing, cleaning, and passivating. Size limits—length 24″ max., diameter 24″ max.; wall thickness—1/16″ through ⅝″.

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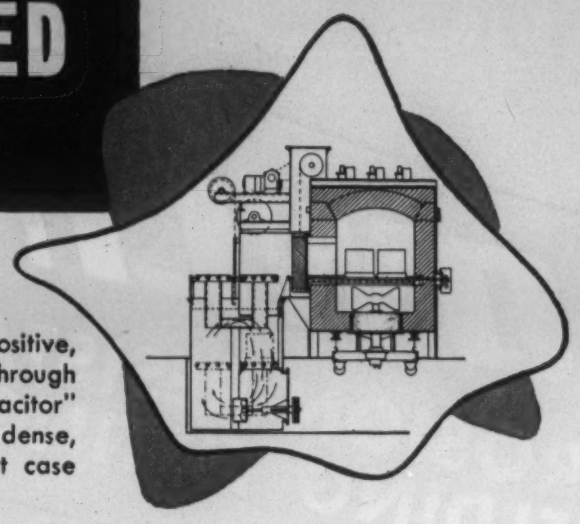
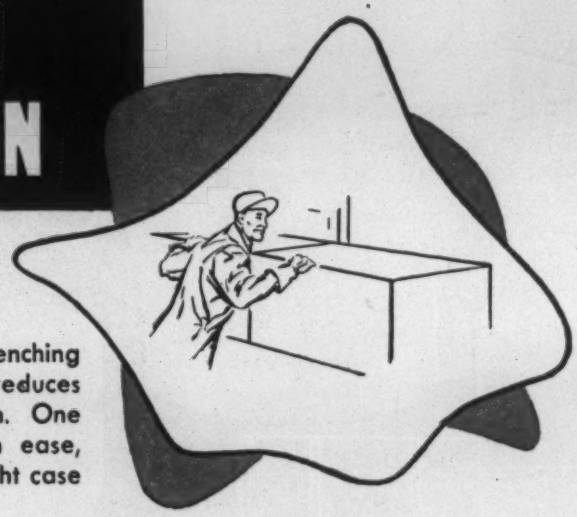
World's Largest Manufacturer of Stainless Welding Fittings

UNSURPASSED QUALITY



Combines the operating economies of large continuous furnaces with the flexibility of batch-type equipment. Positive, directed flow of furnace atmosphere through load, combined with the "heat capacitor" assures rapid, uniform heating on dense, bulk-loaded parts and even on light case work.

GREATER PRODUCTION



The Dow Furnace has established production records in plants throughout the country. Forced, uniform quenching from atmosphere gives full hardness, reduces distortion, eliminates decarburization. One man can operate two furnaces with ease, producing as much as 1500-lbs. of light case work per hour.

WIDER VERSATILITY

Whether it's gas cyaniding, gas carburizing, clean hardening or carbon restoration work, the Dow Furnace is capable of processing a variety of parts having a wide range of heat treatments. To demonstrate the close tolerances of heat treatments, send us samples of your own parts for processing.

AT LOWER COSTS

Reductions in direct labor, material handling, machining and cleaning costs, coupled with improved quality, have resulted in savings amortizing the original cost of the Dow Furnace in a few months. Gas cyanides for ¼ to ⅓ the cost of liquid cyaniding.

THE DOW FURNACE COMPANY

FIRST
WITH MECHANIZED BATCH-TYPE
CONTROLLED ATMOSPHERE FURNACES

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KEnwood 2-9100

Aluminum Photo Process . . .

continued from page 178

the plate can be heated up to the melting point of the base aluminum without affecting the image. In fact, if this heating is done carefully, the aluminum can be melted completely away from the base image, leaving an image which is carried essentially in a thin film of aluminum oxide.

3. The hard scratch resistant surface is easily cleaned because of its smoothness. If desired, it can be washed with soap and water without danger. The surface can be buffed on cloth wheels for bright finish without danger to the image.

4. In view of its resistance to boiling water, the plate is completely sterilizable by normal clinical procedures.

5. The image is substantially grainless, permitting reproduction to degrees of detail equivalent to at least 40 microinches.

6. The faithful reproduction of half tones in normal gradation is possible so that landscapes, portraits, and the like can be readily duplicated.

7. The material is completely nonpoisonous.

Disadvantages

In any new photographic process, disadvantages obviously exist. These are:

1. The plate is expensive, although continued research indicates that costs will be reduced with further effort.

2. Pure whites are difficult to obtain. The plates categorized, as whites are more on the gray side and for this reason, the high degree of contrast needed for portraiture is not presently available.

3. The requirement for darkroom sensitization makes the darkroom procedure somewhat lengthy, though of course on large runs, this processing can be made automatic.

4. The plates are slow, having an A.S.A. speed of the order of 0.1.

5. Thick plates cannot be bent without cracking the anodized layer. Thin plates can be flexed considerably before cracking is developed.

6. The plates are not resistant to strong alkalies.

How Plates Are Produced

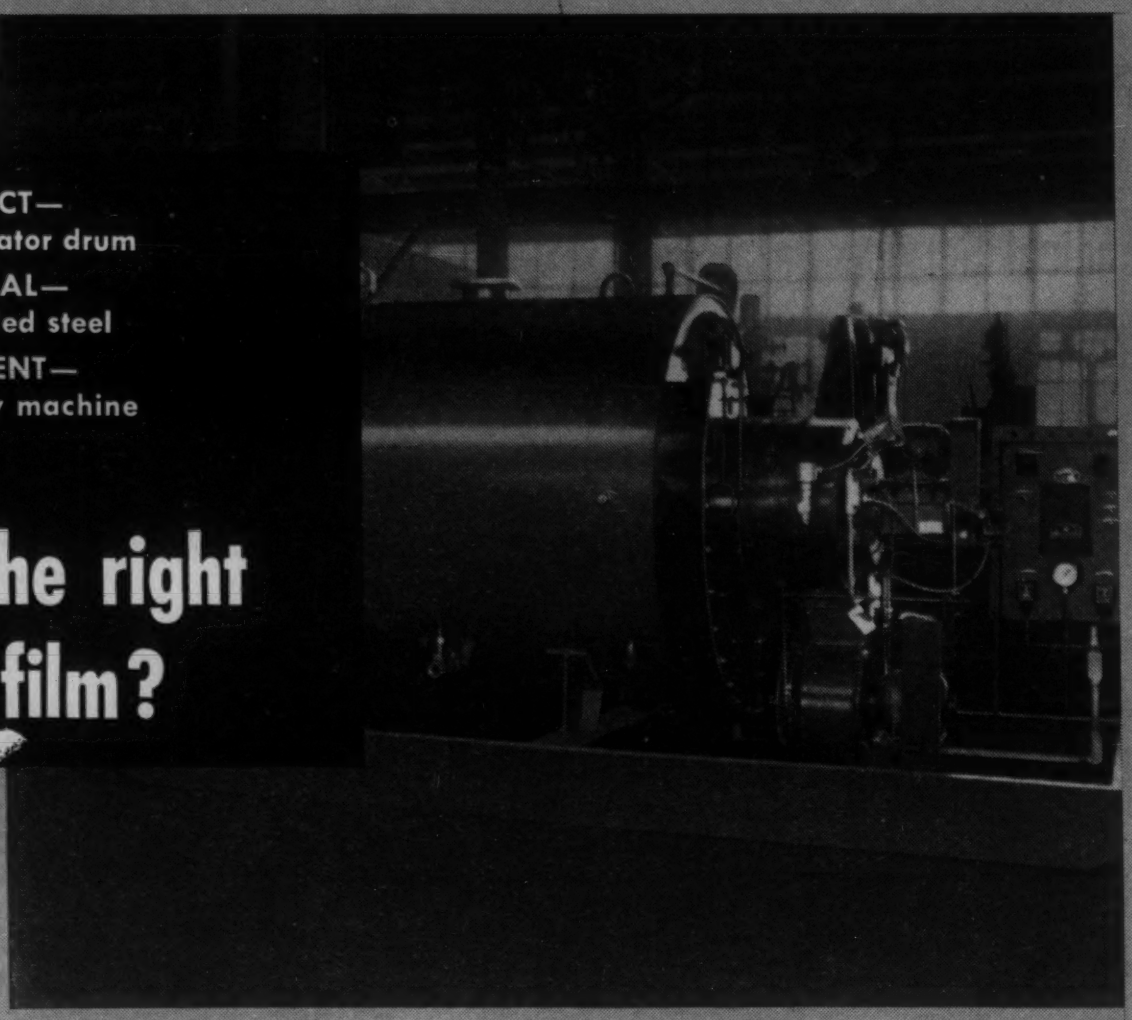
The anodizing of aluminum involves the insertion of a sheet of aluminum in an electrolytic bath in which the aluminum is the anode. Through the use of special conditions

(Continued on page 182)

PRODUCT—
Steam generator drum

MATERIAL—
13/32" rolled steel

EQUIPMENT—
250 kv x-ray machine



What's the right x-ray film?

KODAK INDUSTRIAL X-RAY FILM, TYPE A

MUCH IS GAINED by welding a pressure vessel. In this case dependability of the generator was increased, while weight was reduced 15% and costs dropped 10% to 20%. But each weld must be proved sound radiographically.

To make the radiographs, the radiographer used 145 kv, and Kodak Industrial X-ray Film, Type A, with .005-inch front-and-back lead screens.

Type A has high contrast and fine graininess, and sufficient speed to take full advantage of high kilovoltage machines in radiographing thick or dense materials. It also is first choice for the examination of light alloys with short exposures at low voltage.

A TYPE OF FILM FOR EVERY PROBLEM

To provide the recording medium best suited to any combination of radiographic factors, Kodak produces four types of industrial x-ray film. These provide the means to check welds and castings efficiently and thus extend their use.

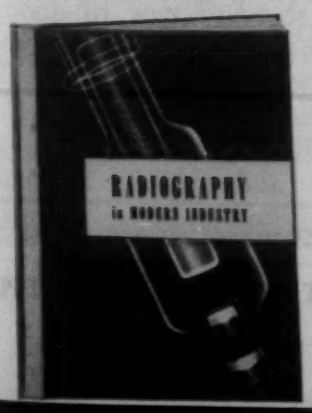
Type A—has high contrast and fine graininess with adequate speed for study of light alloys at low voltage and for examining heavy parts at intermediate and high voltages. Used direct or with lead-foil screens.

Type M—provides maximum radiographic sensitivity, with direct exposure or lead-foil screens. It has extra-fine grain and, though speed is less than Type A, it is adequate for light alloys at average kilovoltages and for much million- and multi-million-volt work.

Type F—provides the highest available speed and contrast when exposed with calcium tungstate intensifying screens. Has wide latitude with either x-rays or gamma rays when exposed directly or with lead screens.

Type K—has medium contrast with high speed. Designed for gamma ray and x-ray work where highest possible speed is needed at available kilovoltage, without use of calcium tungstate screens.

Radiography . . . another important function of photography



RADIOGRAPHY IN MODERN INDUSTRY

A wealth of invaluable data on radiographic principles, practice, and technics. Profusely illustrated with photographs, colorful drawings, diagrams, and charts. Get a copy from your local x-ray dealer—price, $3.

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AMBLER CHEMICALS ACP PROCESSES PENNA.

Technical Service Data Sheet

Subject: PROTECTING ALUMINUM WITH ALODINE®

ALODIZING IS EASY AND EFFECTIVE

The Alodizing process is a chemical one and does not require electrolytic techniques or equipment. Alodizing is simple, foolproof, low in cost, and requires a minimum of equipment. Essentially, the process consists of the following easily controlled operations or steps:

1. Cleaning the work
2. Rinsing the cleaned aluminum surfaces
3. Coating with "Alodine"
4. Rinsing with clean water
5. Rinsing with acidulated water
6. Drying

After treatments. Alodized aluminum provides an ideal bonding surface for paint, wax, adhesive, or other organic finishes. These should be applied in accordance with the manufacturer's directions. Unpainted or exposed areas will be protected by the tough, durable "Alodine" surface.

Flight of the Chance Vought Cutlass, seventh in a line of outstanding fighters and "potentially capable" of flying faster than any other service type jet aircraft in production, land or carrier-based. Substantial surface areas of the Cutlass are constructed of painted Alodized aluminum.

SHORT COATING TIMES AND LOW BATH TEMPERATURES

With the "Alodine" bath at its normal temperature of 120° F., coating time by immersion approximates 1½ minutes and by spraying, 15 to 20 seconds. Coating times and bath temperatures can be varied to suit operating conditions.

"ALODINE" MEETS SERVICE SPECIFICATIONS

"Alodine" applied by immersion or spray complies with the rigid performance requirements of both industrial and Government specifications. The following is a list of Service Specifications which "Alodine" meets at the present time.

MIL-C-5541
MIL-S-5002
AN-F-20
U. S. Navord O.S. 675
AN-C-170 (See MIL-C-5541)
U.S.A. 72-53 (See AN-F-20)
16E4 (SHIPS)

"ALODINE" HAS UNLIMITED APPLICATIONS

Parts can be treated by immersion, by spraying in an industrial washing machine, by flow coating, or by brushing. This means that "Alodine" can be used anywhere, on any part or product made of aluminum. This had led to widespread use of the Alodizing process: 1. by fabricators of aluminum products in all industries to assure the utmost in product protection and finish durability; 2. by manufacturers of aluminum who are supplying Alodized aluminum sheets and coils from the mills.

In general, small size products or parts are processed rapidly and conveniently in immersion equpiment, which can be mechanized if production volume justifies it. For large production of formed parts, or for Alodizing coiled stock, strip, or cut-to-size sheets, a five-stage power spray washer is most convenient. Airplanes, trucks, trailers, housing, railway cars, bridges and other large units are Alodized in a simple brush-on or flow-coat process.

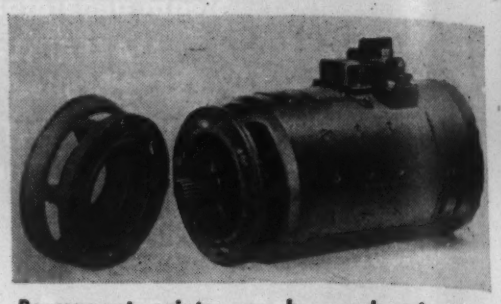
CHEMICALS ACP PROCESSES

WRITE FOR FURTHER INFORMATION ON "ALODINE" AND ON YOUR OWN ALUMINUM PROTECTION PROBLEMS.

CHEMICALS ACP PROCESSES

Aluminum Photo Process . . .

Continued from page 180



Permanent prints can be made of prints which require frequent handling. Smudges and finger marks can be removed by washing the plates.

of bath composition, temperature, voltage and current, an oxide layer which is probably a hydrated form of the oxide is formed on the surface of the aluminum. Both the character and the thickness of the deposit can be controlled by the technique used in the electrolytic treatment. In this condition, the anodic film is porous and highly absorbent and is readily scratched and disturbed.

It is in this porous state that all of the various treatments useful for this photographic process are carried out from the deposition of the silver salts to the sensitization, and the processing. If the plates were placed in service in this condition, they would be very fragile since the surface is readily scratched. They are also still absorbent so that they pick up dirt and grease to such an extent that the qualities of the image would be rapidly destroyed. In order to prevent this, the plate must be subjected to a heat sealing process. This is normally accomplished by boiling the plate for an extended period in solutions of salts which either hydrolyze to form hard insoluble compounds in the pores or react with the aluminum oxide layer to form the hydrolyzable salt. After heat sealing, the surface becomes resistant to mechanical and chemical attack. The mechanical properties may be likened to those of a glass surface while the chemical properties are substantially equivalent to those of alumina.

Aluphoto plates are supplied in two principal types: one is transparent and colorless, the other is an opaque pearl gray color. The first is a fairly standard type of anodizing and with its use, the backgrounds are the metallic surface of the aluminum, that is, silver in color. The second is identified by the name "Ematal" and exhibits unusual re-

(Continued on page 184)

roll formed shapes . . . .

● We take the difficult production jobs off your shoulders. Roll forming equipment speedily turns out intricate sections . . . sized, notched and punched to your specifications. Shapes are rolled with dies that are precision-made in our own plant.

Write for descriptive brochure.

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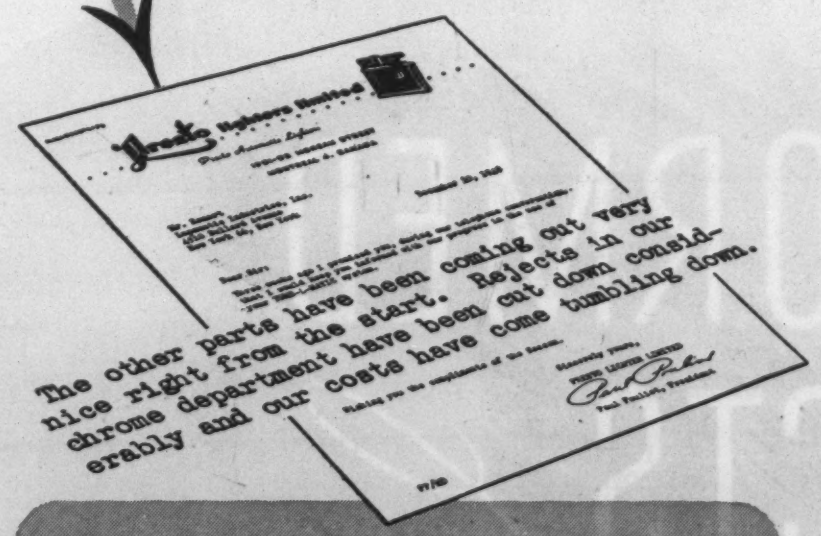
"...and our costs have come tumbling down."

TUMB-L-MATIC helped Presto Lighter . . . TUMB-L-MATIC can help you.

Presto Lighters Ltd., was unfamiliar with Tumb-L-Matic and was skeptical about cutting finishing costs with Tumb-L-Matic methods, but they were willing to be shown. And that is just what Tumb-L-Matic's engineers did. They answered with a detailed study of Presto's finishing operation . . . analyzed a sample lighter and then recommended an individualized low-cost Tumb-L-Matic Process. More than satisfactory results are indicated by Presto's letter. Tumb-L-Matic is a proved process which scientifically combines equipment, compounds, supplies and techniques. It combines revolutionary new developments in definning, cutting, smoothing and polishing metal — no matter what the product's size or shape.



TRY IT BEFORE YOU BUY IT!

Our experienced engineers analyze a sample (or detailed description) of your product, recommend an individualized, low-cost TUMB-L-MATIC PROCESS complete with production data which enables you to figure finishing costs before you invest a cent. Write and tell us about your product — or better still, send a sample. Bulletins on request.

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FORMERLY LUPOMATIC INDUSTRIES, INC.

4510 BULLARD AVE. • NEW YORK 70, N.Y.

Aluminum Photo Process . . .

Continued from page 182

sistance to abrasion and chemical attack. The pearl gray layer is obtained by introducing white pigments into the anodized layer during the electrolytic treatment.

Processing of the Plate

The plates are received by the user in the non-sensitized condition, in which case they are stable indefinitely and can be handled without special precaution. Basically, the non-sensitized plate is transformed into a photographic medium by simple preparation in two main steps: (a) the sensitization step, and (b) the photographic processing. Both sensitization and photographic processing are completed in the darkroom under red light without special precautions.

After sensitization, the plates are ready for photographic processing. The plates have a low speed, of the order of 0.1. A.S.A., thus being comparable to a slow silver bromide printing paper. With the exception of this low speed, the photographic processing is substantially equivalent to that used for photographic paper.

After exposure, developing, fixing and washing, the image has a light brown color and if deep blacks are desired, the image may be heavily toned in gold, platinum, or palladium. To obtain special effects, most of the acid toning techniques normally used for photographic plates can be used.

The heat sealing step is necessary to close the pores in order to develop the scratch and corrosion resistant surface which is characteristic of the Aluphoto plate. The various polishing and buffing steps always follow the heat sealing process. For best results in finishing, the buffing on the wheel requires addition of a 600 F abrasive such as alumina to the cotton.

Applications

The Aluphoto process was introduced in Europe early in 1951, and is enjoying considerable commercial application. The plates are being

(Continued on page 186)

NOTE

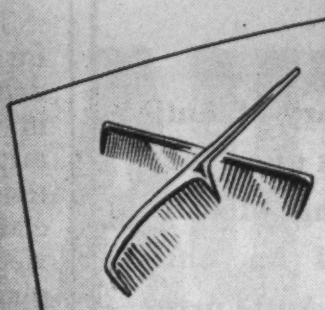
Engravings for this article were made directly from Aluphoto prints.

Naugatuck

ROYAL FAMILY OF PLASTICS

Known by the customers we keep . . .

Here are just a few of our many customers . . . and the products we helped them make finer.



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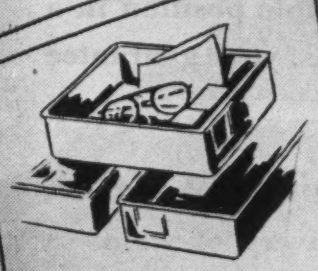
Vulcanized Rubber & Plastics Company
KRALASTIC

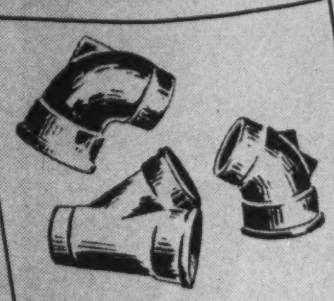
"n'Icer" Ice Bucket
Sponge Rubber Products Company
MARVINOL

Parker Pen
Parker Pen Company
KRALASTIC

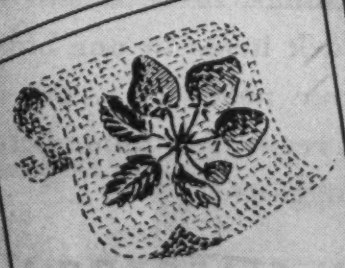


Tote Boxes
American Optical Company
KRALASTIC

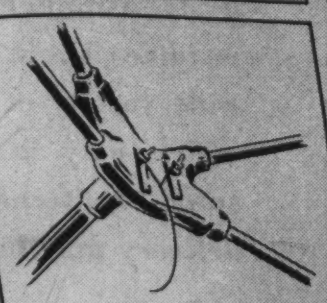
Life-like Dolls
Horsman Dolls, Inc.
MARVINOL



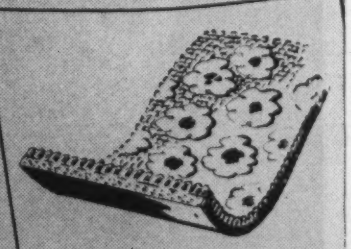
Pipe Fittings
Orangeburg Manufacturing Co., Inc.
MARVINOL



Household Fabrics
Elm Coated Fabrics Company
MARVINOL



TV Antenna Insulator
Lanfare Molded Products, Inc.
VIBRIN



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Anti-Corrosive Metal Products Co., Inc.

1927–1952

Manufacturers of STAINLESS STEEL FASTENINGS

CASTLETON-ON-HUDSON, NEW YORK

Aluminum Photo Process . . .

continued from page 184

used in a large number of industries in the form of name plates, sign plates, identity cards, identification of electric motors and equipment, permanently placed instruction sheets, time tables, advertising scales and instruments, and signs of all types. A major field of established application is in the field of instrumentation, where the Aluphoto plate is used for photographically produced scales, dials, slide rules, graphic descriptions and designs, precision instruments, watch faces, rules, protractors, and the like.

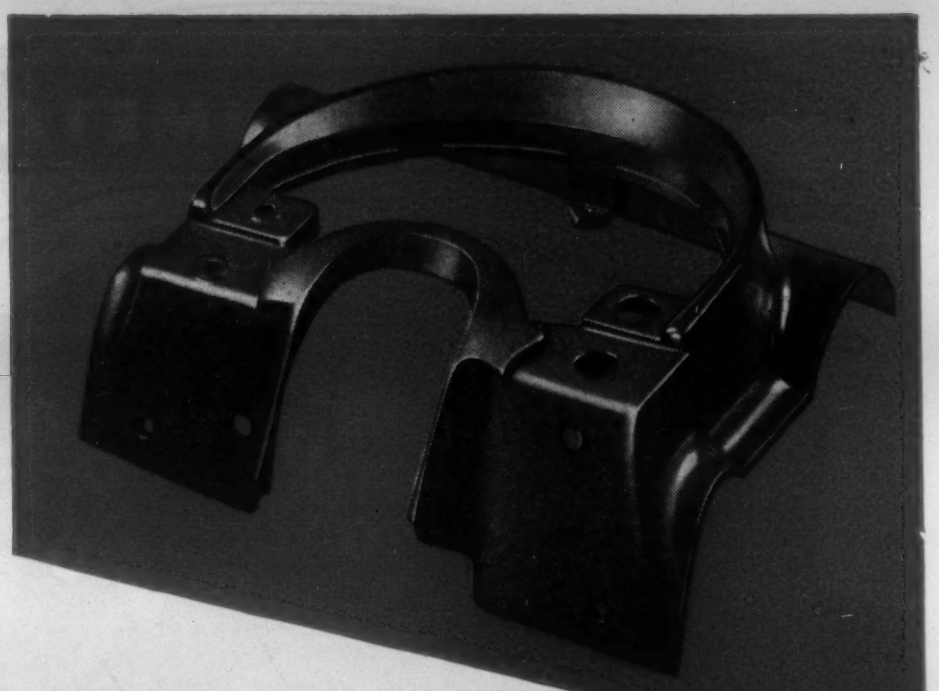
The Aluphoto plate can be used for preparation of permanent maps, drawings, standard reference sheets in the workshop and factory, sea maps and field maps. In view of their resistance to salt corrosion and general physical stability, there is obvious application on shipboard. Applications exist for archival purposes, in duplication of documents in either normal size or in microfilm, for portraiture on vanity cases, cigarette cases, backs of mirrors, landscapes for publicity, for railway, aircraft and shipboard use and, as a matter of fact, for any document or printed sheet which requires repeated and rough handling and good resistance to exposure to weather. In general, the permanence and durability of the pleasing image formed on the Aluphoto plate has provided the possibility of substitutions for materials normally used in the photographic industry when the physical properties of Aluphoto make such a substitution desirable.

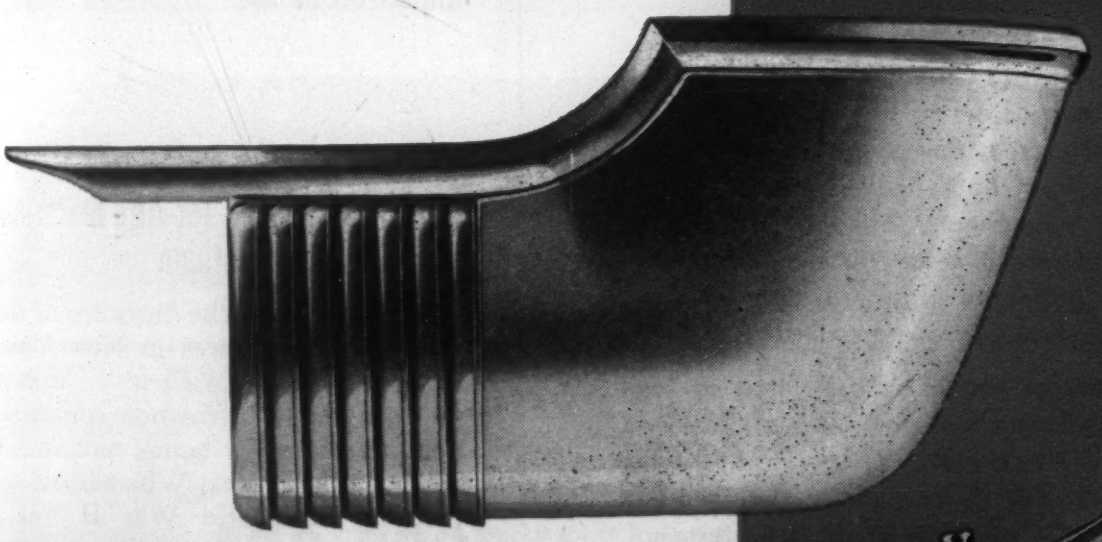
From the defense point of view, the Aluphoto plate is attractive because in the unsensitized condition it is unaffected by nuclear radiation and yet it is still completely useful for photographic purposes thereafter without fear of damage or destruction of the image. An unusual application for the Aluphoto plate is in the duplication of movie films which are to be permanently stored. In this particular case, the films would be projected by reflection. In view of the high heat durability of the Aluphoto plate, extremely intense illumination can be used in the projection of lantern slides without fear of damaging the plate.

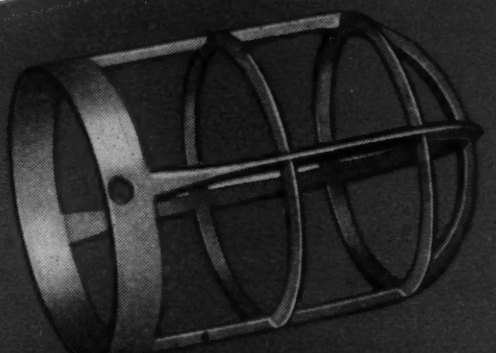
References

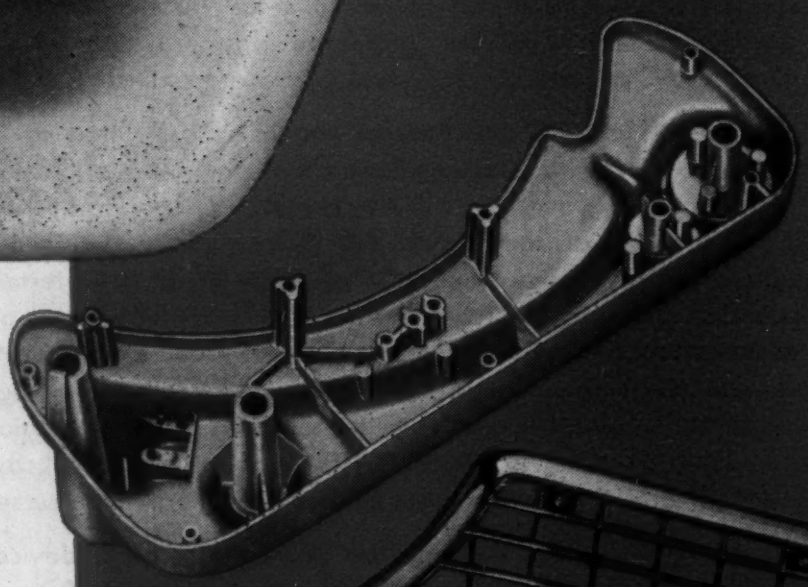
German Patent No. 607,012; 608,270; 615,092; 619,450; 620,664; 622,480.
M. Schenk, *Aluminum Swisse*, No. 2, Mar. 1951, pp. 61-63.

You're always right with AUTO-LITE Die Castings









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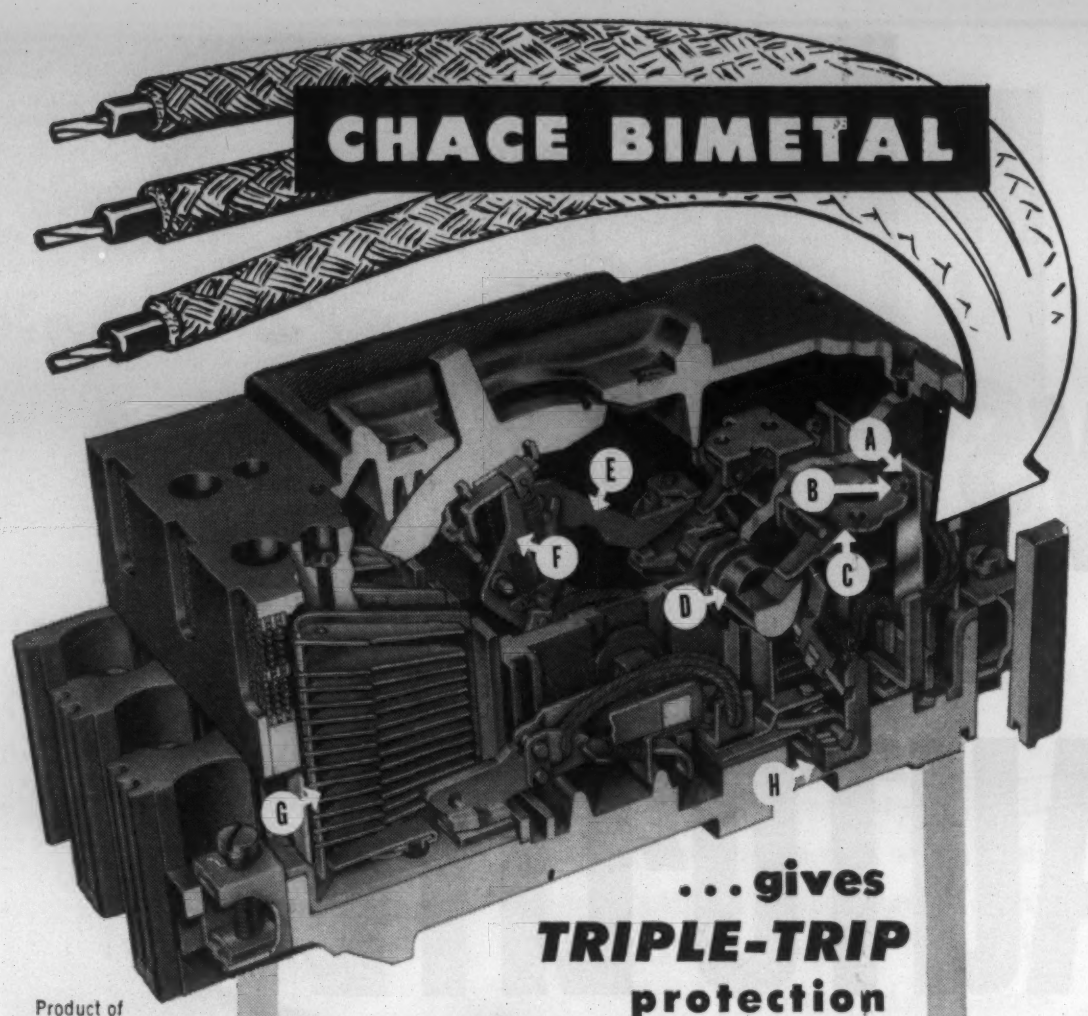

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The versatile Chace Bimetal action is best suited to temporary overloads—with relatively long delay on light overloads and short delay on heavy overloads. When a sustained overload is on the circuit the current heats the Bimetal Trip Element (A) causing it to flex toward the low responsive side in the direction of the load terminal. The Latch (B) slides off the Transfer Arm (C) which pivots under pressure of its spring, pressing down the Trip Bar (D), causing it to rotate and release the Trip Actuating Arm (E). This allows the Trip Toggle Mechanism (F) to operate and open the contacts. Arc interruption is aided here by "DE-ION" Arc Chutes (G). The magnetic action (H) causes "snap-action" and the instantaneous breaking of short-circuit currents.

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Thermostatic Bimetal
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News Digest

continued from page 13

tion, the import duty on lead was suspended Feb. 12, eliminating the two-price system and bringing the costs of foreign and domestic lead together. Meanwhile, production from domestic mines, hampered last year by labor shortages and strikes, is progressing at an accelerated pace. The third important source of lead, scrap, is also providing a greater supply than a year ago.

As a result, it is expected that total lead available in the United States may reach as much as 1,300,000 tons, or about 150,000 tons more than a year ago. This quantity should take care of all requirements in this country without difficulty.

Consumption is difficult to estimate, particularly since Government military and stockpiling requirements are not clear and change from time to time. Nevertheless, lead is not a war metal to the same extent as some other metals, and the defense program should not have the same heavy impact on its use.

Wilson Discusses Jet-Age Materials Problems

In a speech to the Institute of the Aeronautical Sciences in New York, Defense Mobilizer Charles E. Wilson spoke at length of the new considerations in materials being met in the armament program. Whereas air superiority in World War II was a function of the perfection of mechanical devices in the form of reciprocating engines, it is now a function of temperatures and pressures that can be withstood by metals, Mr. Wilson said.

In the last war, maximum efficiency in an aircraft was guaranteed when a piston was made to move through a cylinder with a minimum of limitations imposed by fundamental laws of friction mass and human perfection in an assembly of thousands of intricate parts.

In this age there are fewer such limitations because thrust in jet engines is very largely a function of temperature and is limited only by the capacity of materials to withstand high temperatures. Hence, major air superiority is a product of

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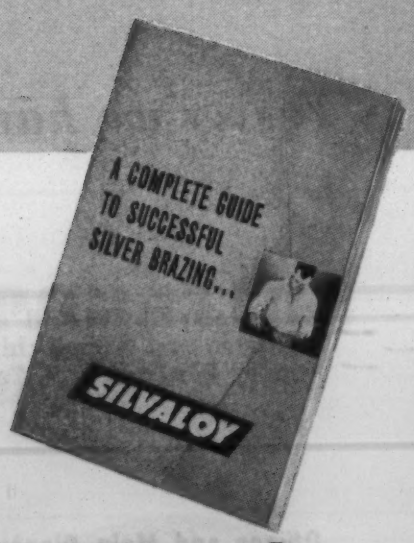

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the temperatures that the physicist can induce, coupled with the materials that the matellurgist and ceramist can develop to withstand the high temperatures.

This condition has forced us to use materials such as columbium, cobalt, tungsten, cerium and others that were largely academic curiosities prior to the recent demands of jet aircraft. Most of these metals are found in useful quantities only in foreign lands; their extraction from ores is immensely complicated by comparison with the well-known metals such as iron and copper; their melting points are so high that they are very difficult to alloy with a base metal such as iron. Along with their high temperature properties goes brittleness that makes forming difficult—all this plus the fact that high temperature-resisting, hard, brittle materials are inherently difficult to weld. The utilization of these exceptional materials has been a limiting factor in jet engine planning.

Head of DPA Defends Basic Metals Agreements

"American self-sufficiency in raw materials is a myth," Defense Production Administrator Manly Fleischmann declared at a luncheon of the Foreign Policy Association held in New York.

He pointed out that without material from other countries we cannot build our defenses. Of 38 important industrial minerals, we are self-sufficient in only nine and, in 20 produce only 60% of our needs. There are seven items in which we depend entirely on outside sources.

The United States, he insisted, is not being "short-changed in the division of available supplies" through the International Materials Conference. He declared that this country has been regularly receiving allotments from IMC far greater than our pre-Korean share of the international supply.

Current difficulties with importing copper, Mr. Fleischmann believes, result chiefly from inability of this country to find a seller abroad who would deliver the metal at present domestic ceiling prices. The essence of the Controlled Materials Plan, he

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Our engineering department will be glad to consult with you to see if you can fabricate stainless with your existing tools. You may choose to save money by using lighter gauge material and take advantage of the superior strength of stainless.

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Other Profilometers are used as shop tools in two parts-machining departments. Still others are used in tool inspection and in investigation-inspection. The latter section—with the help of the Profilometer—determines if the engineering specifications for surface finish are being met.

Extreme accuracy has always been stressed in the more than 180,000 different parts that go to make up National Cash Register accounting machines and adding machines. Because of that policy, the National Cash Register Company was one of the original purchasers of a Profilometer. That investment has paid off many times.

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reminded those present, was the channeling of scarce materials, not into the hands of the highest bidder, but to users who needed them for the defense effort. These criteria are essential in the international distribution of copper, nickel and other strategic materials, he said.

If the United States had not made arrangements to get aluminum from Britain, it would have meant the closing of numerous small plants in this country, he said.

In reference to the deal in tin, he stated it drastically altered a most difficult and irritating international dilemma. It made the assurance of an adequate supply of this metal at reasonable prices now seem capable of attainment in the near future.

The head of DPA added that "we have given up a limited quantity of steel that might possibly have been used here and enabled Britain to sustain its mobilization effort without slackening. In return, we have received metals that will help us in the months ahead beyond any possible sacrifice in steel."

The basic idea of the material interchanges, he declared, was that each nation in the free world would contribute what it could to the attainment of mutual security.

Titanium Metal Production Soars to Record High

Titanium metal was produced commercially on a record breaking tonnage scale by two companies in 1951, according to the Bureau of Mines, United States Dept. of the Interior. Several new groups were organized for promoting the production and use of titanium metal.

Production of titanium sponge in 1951 is estimated at 700 tons, coming from plants operated by E. I. du Pont de Nemours at Newport, Del.; Titanium Metals Corp. of America at Sayreville, N. J.; Niagara Falls, N. Y.; Henderson, Nev.; and leased facilities of Boulder City, Nev.; and the Crane Co. at Chicago, Ill. Titanium sponge was produced at the end of 1951 at the rate of about 1,400 tons per year.

Titanium sponge acceptable to the Government has the following specifications: Titanium content, 99.3% minimum; total maximum impurities,

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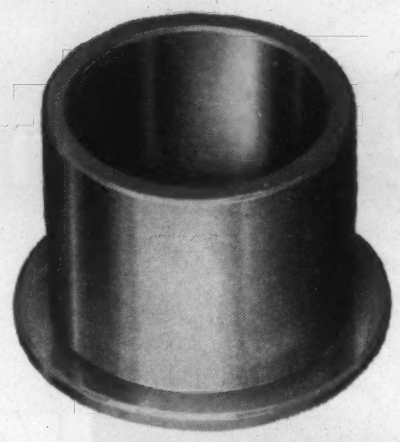
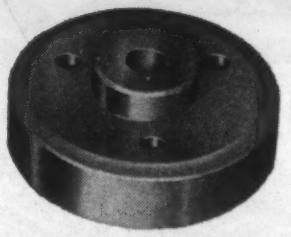
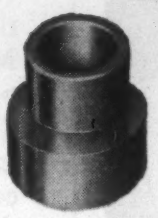


iron pivot bearing 23¢

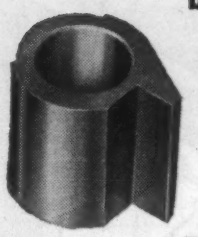


bronze ratchet hub 23½¢

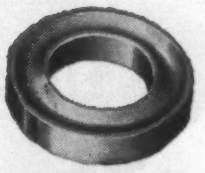
copper fuse end 1½¢



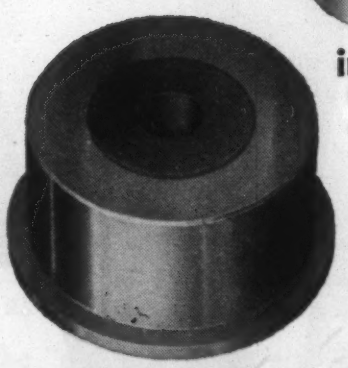
bronze eccentric hub bearing 6½¢



iron cam 5½¢

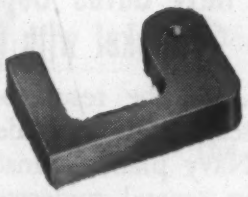


iron pump gland part 1½¢



gramix backed graphitar roller 85¢

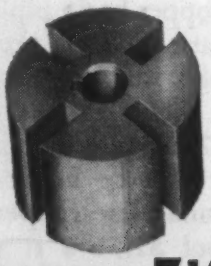
eccentric supporting bearing 2½¢



iron tripper 5¢

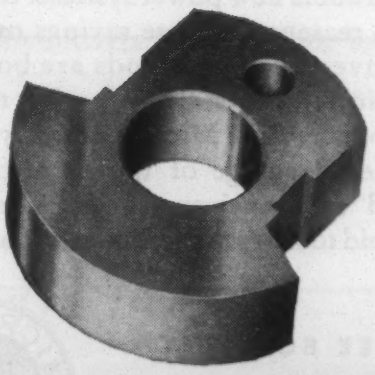
nickel silver gear 3½¢

switch take-up washer 7¢



iron rotor 7½¢

bronze bearing plate 9¢



iron ironer cam 10¢

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0.7%; iron, 0.25% max.; nitrogen, 0.03% max.; chlorides to be established based on operating and storage experience; and hardness after arc melting in an inert atmosphere less than 250 Vickers or 61 Rockwell A.

Steel Scrap Supplies Still Low

Despite the well organized campaign of steel producers and consumers and the collectors of scrap, supplies of iron and steel scrap remain dangerously low. Several open hearth furnaces were forced out of production early this year, as the severe winter weather delayed the collection of scrap.

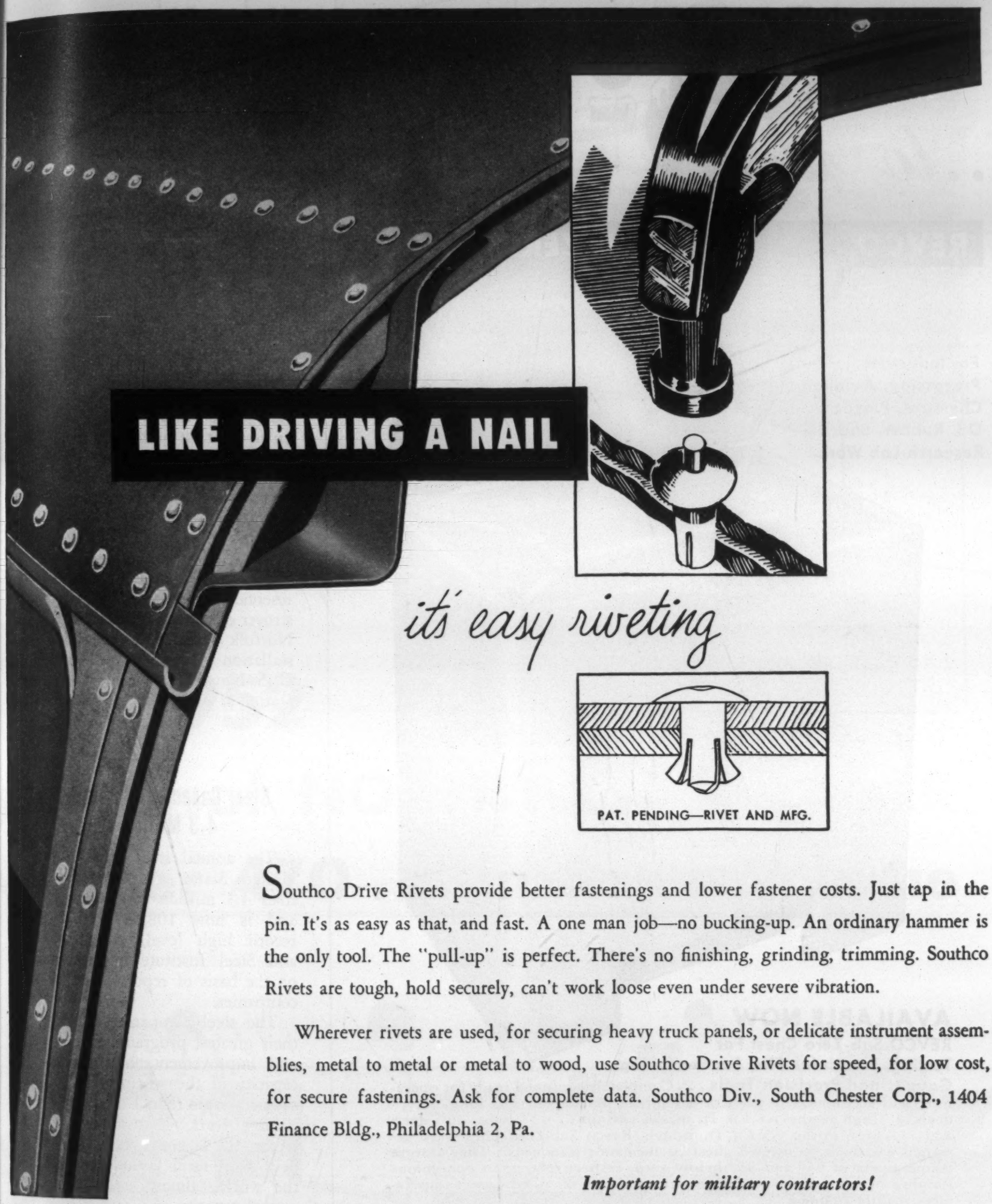
Scrap inventories in the hands of consumers were estimated shortly before the end of 1951 to be 28% less than at the beginning of the year. Meanwhile, the production of steel plants and founderies expanded. Thus, each thousand tons of scrap in inventory at the end of the year equalled a supply for a shorter period than at the start of the year.

Navy Saves Copper, Brass and Nickel with Plastic Pipe

As the result of an eight-month sea test aboard a destroyer escort, the Navy plans to install plastic piping in several minesweepers now being built. In the minesweepers where the plastic installation is planned, about two tons of copper and nickel will be saved. In addition, there will be savings in copper-brass piping.

Installation costs promise to be considerably less with plastics, once quantity production is begun. The cost of 2-in. plastic pipe of 1/8-in. thickness will be about $1.70 a ft, while similar size copper-nickel pipe costs about $1.55 a ft and stainless steel pipe costs about $2.25 a ft. Black steel pipe, which corrodes and therefore is not used for sea water piping except in times of great material shortages, costs $1.55 a ft.

Maintenance costs should also be less. The tests aboard the destroyer escort have indicated that for many purposes plastics outlast metal. Even in compartments where the air was very hot the plastic pipes did not cor-



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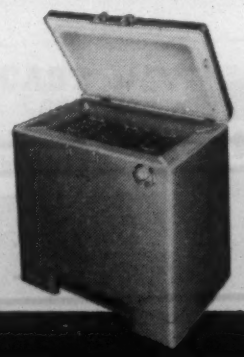

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rode or burn. Several pieces of plastic pipe were installed just above the boiler drum, where the air temperature reached 180 F. After eight months of service, this pipe was not affected.

Plastic pipe also does not corrode from salt water and is resistant to shock. Sections of plastic pipe carrying salt water under pressure were installed just aft of the forward guns. They remained good while nearby steel pipes had to be removed because they were damaged by the combination of corrosion and shock. The chief engineer of the destroyer escort also reported that during a storm, in which the pipe was subjected to severe stress and vibration, the plastic pipe was not visibly damaged. Several metallic pipes, however, gave way.

Plastic pipe was installed in representative places throughout the destroyer escort for purposes of the test. Norfolk Naval Shipyard did the installation work under guidance of the U. S. Naval Engineering Experiment Station at Annapolis.

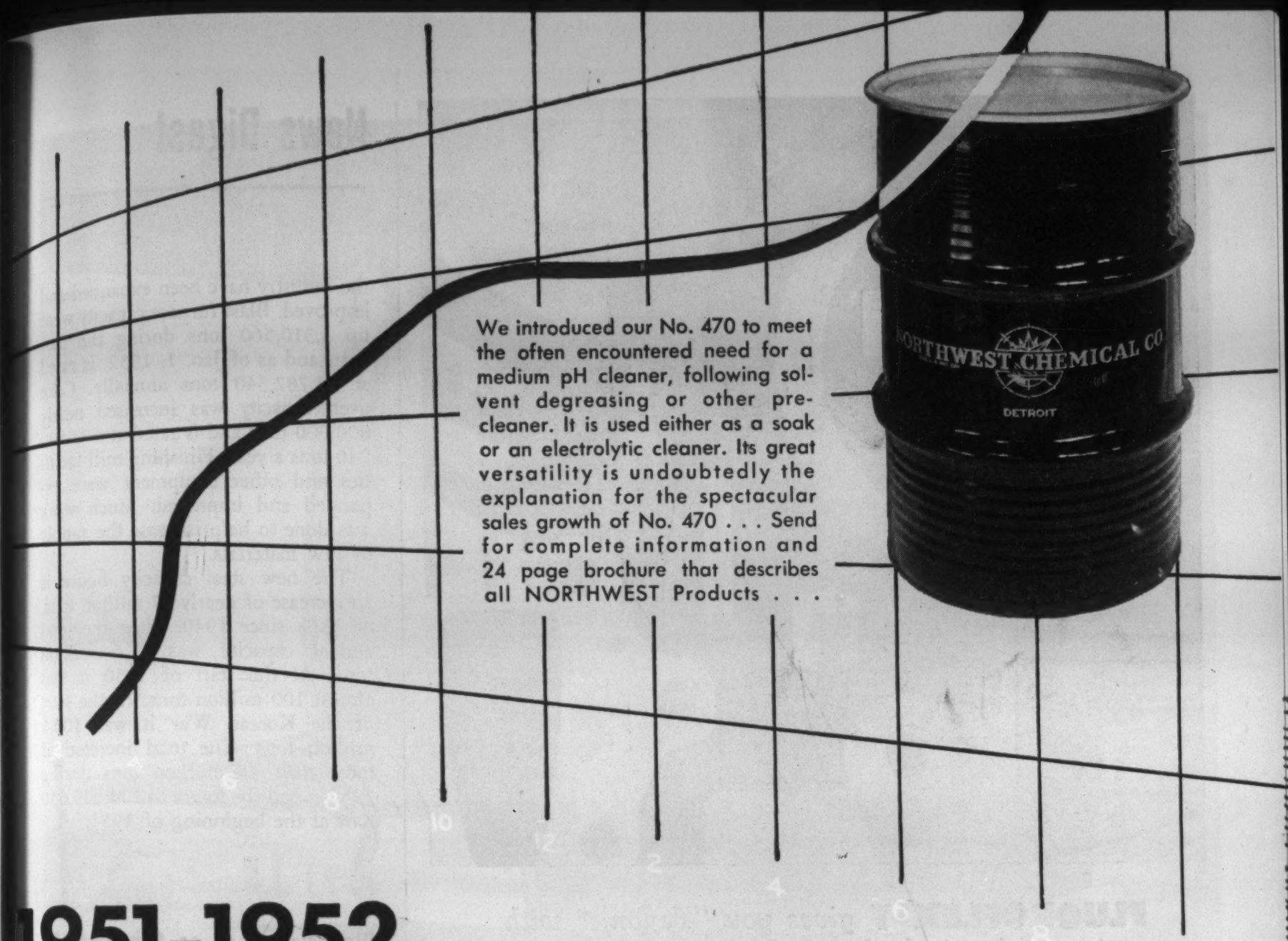
Steel Capacity Increases Over 4.3 Million Tons

The annual steel capacity of the United States was increased more than 4.3 million tons during 1951 and is now 108,587,670 tons, a record high level, American Iron and Steel Institute has announced, on the basis of reports filed by steel companies.

The steel companies, engaged in their greatest programs of expansion and improvement, have raised the capacity of the world's largest steel industry more than 17.3 million tons in five years. That amount of increase, the largest ever accomplished in a short term period anywhere in the world, almost equals the total annual capacity of Great Britain and is about half of the estimated total capacity of Russia, second largest steelmaking nation.

The annual capacity is rising toward an expected 120 million tons in the United States sometime in 1953. It is now only 9.5% below that figure. A considerably larger increase is scheduled to be made this year.

To support the rise in steelmaking capacity, other producing facilities in



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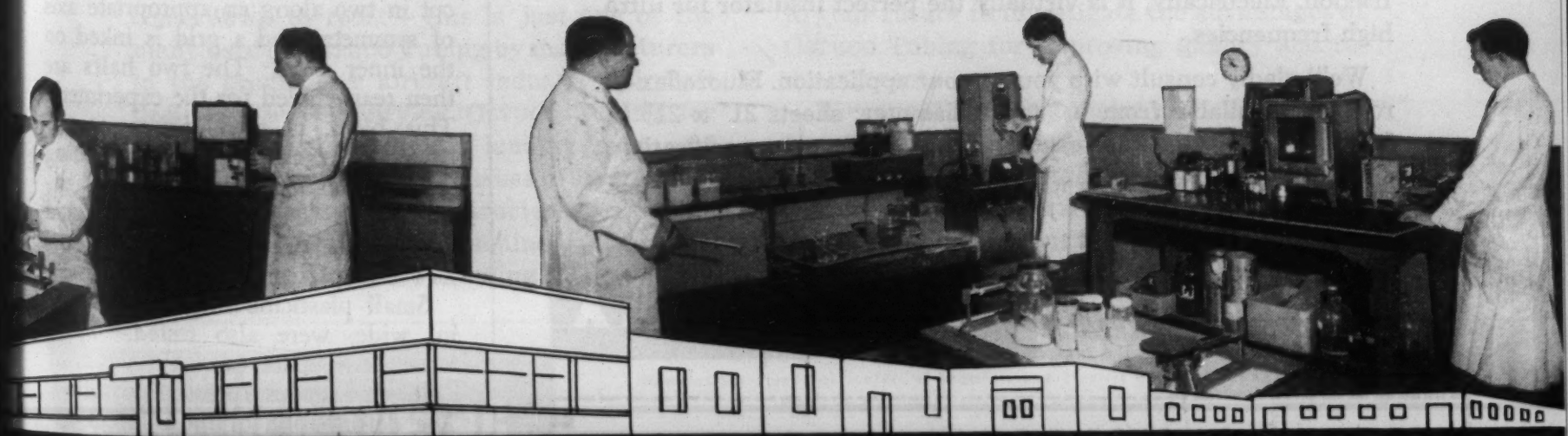

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the industry have been expanded and improved. Blast furnace capacity went up 1,310,560 tons during the past year, and as of Jan. 1, 1952, is rated at 73,782,340 tons annually. Coke oven capacity was increased nearly 800,000 tons and is rated at 67,060,240 tons a year. Finishing mill facilities and other equipment were expanded and improved. Much work was done to help increase the supply of raw materials.

The new steel capacity figure is an increase of nearly 27 million tons, or 33% since 1940. Then the total annual capacity was 81.6 million tons. At the start of 1950 it was almost 100 million tons. At the start of the Korean War it was 100.5 million tons. The total increase of more than 4.8 million tons during 1950 raised the figure to 104,229,650 tons at the beginning of 1951.

Plasticine Used as Substitute for Metals in Strain Experiments

In the January 11 issue of the British magazine *Metal Industry*, W. C. F. Hessenberg of the British Iron and Steel Research Assn. presents a surprising experimental technique. He has used plasticine as a cheap, easy-to-work substitute for metals in studies of deformations beyond the elastic limit.

In studies of wire drawing and extrusion, a white plasticine block is cut in two along an appropriate axis of symmetry and a grid is inked on the inner faces. The two halfs are then reassembled for the experiment. This block is then drawn or extruded just as the metal being studied would be. After the deformation, the halfs are separated and the changes in the grid show how each part of the piece deformed.

Small plasticine forging ingots, 2 in. wide, were also tested. These were made up of extruded sheets of different shades pressed together. The deformation of these layers under forging pressures gives an accurate indication of the behavior of metals.

Experiments of this sort on real metals necessitate somewhat expensive equipment, as the forces involved are rather high. Fortunately, plasticine provides a very good

Legs for lethal eagles

Legs for lethal eagles — hydraulic landing gear that cushion Uncle Sam's big bombers as they come down to roost — this is just one of the many uses of OSTUCO Tubing by manufacturers in the progressive aircraft industry. Aircraft designers are specifying OSTUCO Tubing for fuel lines, engine mounts, landing gear, and many other applications because of its inherent strength without weight characteristics and the ease with which it can be machined, formed and fabricated to the most exacting requirements.

But whether your products are aeronautical or of a distinctly different nature, you owe it to your future to investigate the advantages of OSTUCO Tubing for improving quality and reducing cost.

We cannot always promise early delivery estimates on new civilian orders, because of military demands, but it will pay you to consult our experienced engineers about OSTUCO Tubing when redesigning your products to meet future competition.

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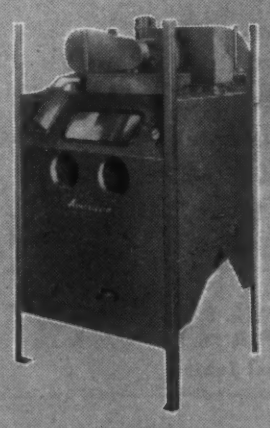
IS THERE A BETTER METHOD OF PRECISION FINISHING?

The answer is finally YES. The long search for a fast, easy method of close tolerance finishing has been successful. "Hand" finishes are now produced mechanically in a *matter* of *seconds* in the new Liquamatte to eliminate many tedious operations. Scale, burrs and grinding lines are quickly removed while holding tolerances of .0001". Dies, molds and cutting tools are cleaned and/or finished without breaking down sharp edges or corners.

The Liquamatte is a form of wet blasting that has been so simplified that it overcomes the operating difficulties previously connected with this process.

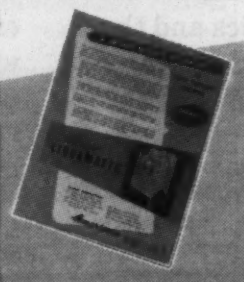
Typical heat treated forging die, one half of which has been cleaned with the Liquamatte using a fine mesh liquabrasive.

Model 43 American Liquamatte Cabinet, with exclusive vertical pump.



Fourteen advanced design features cut finishing time, reduce downtime and increase production. Push button controls are located at the work station. There are no time-killing valves to open or close. Parts are quickly moved in and out of the work-cabinet through convenient openings. When changing abrasive size, the hopper is drained in seconds without bailing.

These are just a few of the many reasons why the Liquamatte is a better method of precision finishing. We would like the opportunity to prove it to you with a demonstration.



GET THE FACTS

Send for Bulletin 23, describing the advantages, specifications and applications of the new Liquamatte.

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News Digest

model of a metal. At first sight this might appear surprising, since its structure must be very different from that of a metal, but in this instance, consideration is being given to strains distributed over regions of very much larger than atomic or molecular dimensions and, provided that in certain large scale physical effects, such as constancy of volume under plastic flow and shape of the stress-strain curve, the model is not too dissimilar, and its use is justified. Its change in volume is less than 0.2% at 50% reduction in compression, and its stress-strain curve is similar to that of metals.

Ways Suggested to Conserve Nickel in Small Springs

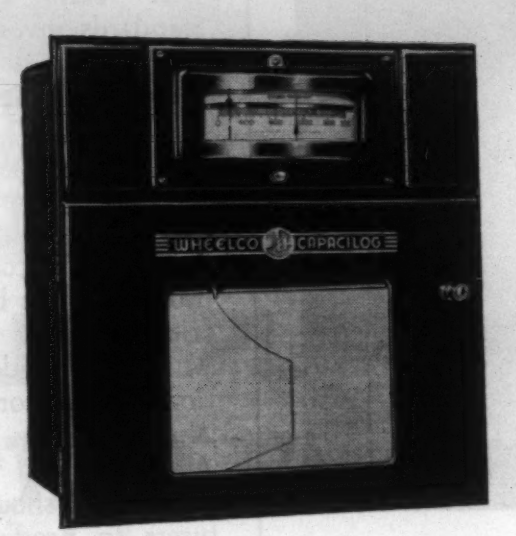
George R. Gohn of the Bell Telephone Laboratories reports on the work of ASTM Committee B-5 on Copper and Copper Alloys in the January issue of the *ASTM Bulletin*. This committee suggests that nickel can be conserved by using 12% nickel silver sheet instead of the 18% alloy in small flat springs.

This proposal was originally made in World War II, and the ASTM specifications were revised in 1946 to include the new alloy, designated Alloy No. 8. The nominal composition is 56.5 copper, 12 nickel and 31.5% zinc. This compares with 55 copper, 18 nickel and 27% zinc in Alloy No. 4, formerly used. The properties are similar in both alloys in the spring hard temper.

Source of Hydrogen Found in Porcelain-Enameled Steel

Hydrogen gas evolved during and after the firing operation has for some time been recognized as a cause of defects in porcelain-enameled and ceramic-coated steel. At high temperatures the gas may cause blistering during the firing, or reboil (the blistering of a vitreous coating when reheated after the first firing). At ordinary temperatures,

wheelco instrumentality



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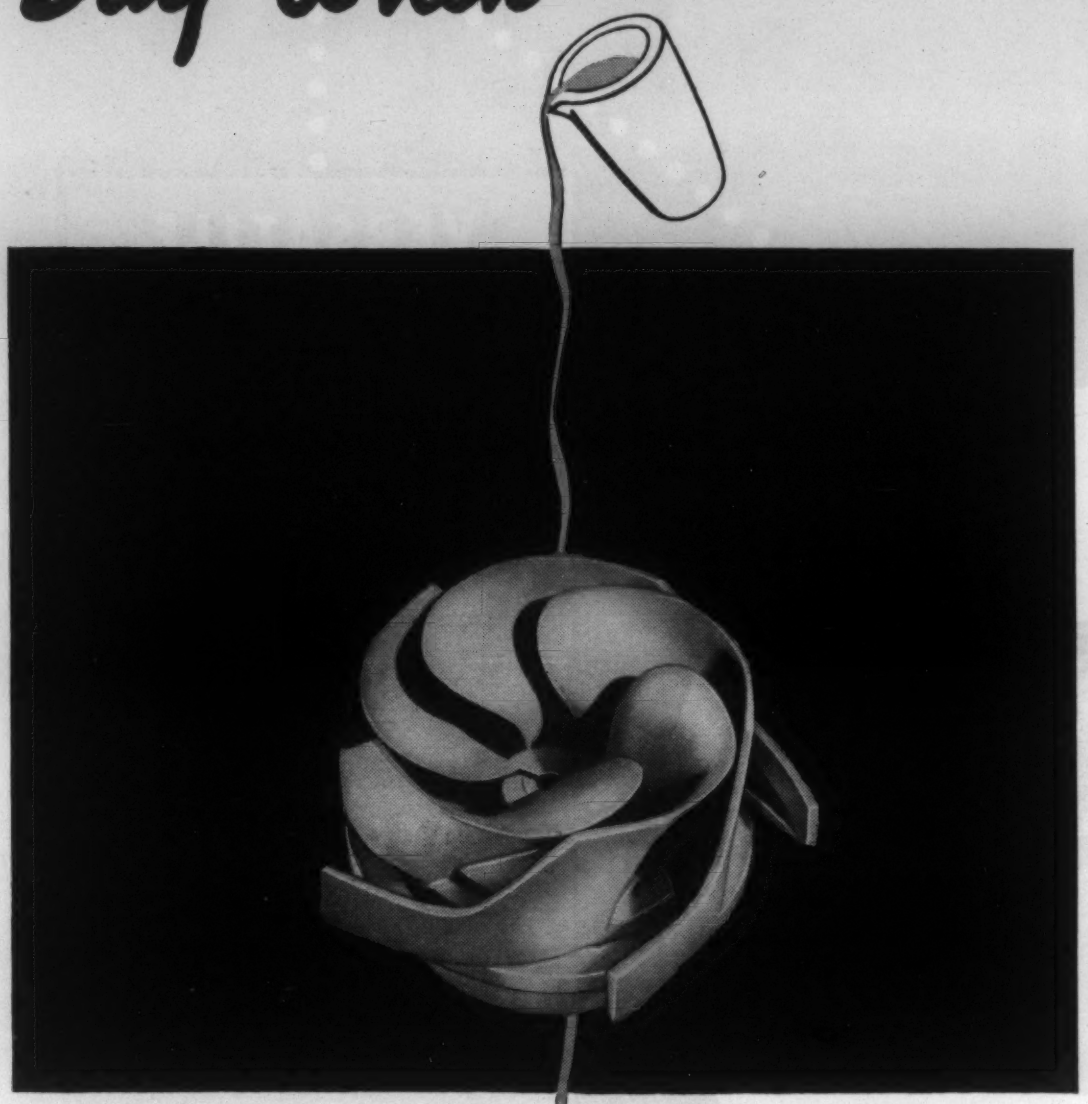

This part is an *Investment Casting*, made by the expendable pattern process. We mass produce it for $10.50. It's the kind of part that can't be made in one piece by any other means—*at any price.*

Our Investment Castings frequently replace complicated assemblies. Often eliminate expensive pre-machining and finishing operations. Compromises in design are fewer because we cast in almost *any shape*—simple and complex—and in 160 different ferrous and non-ferrous alloys.

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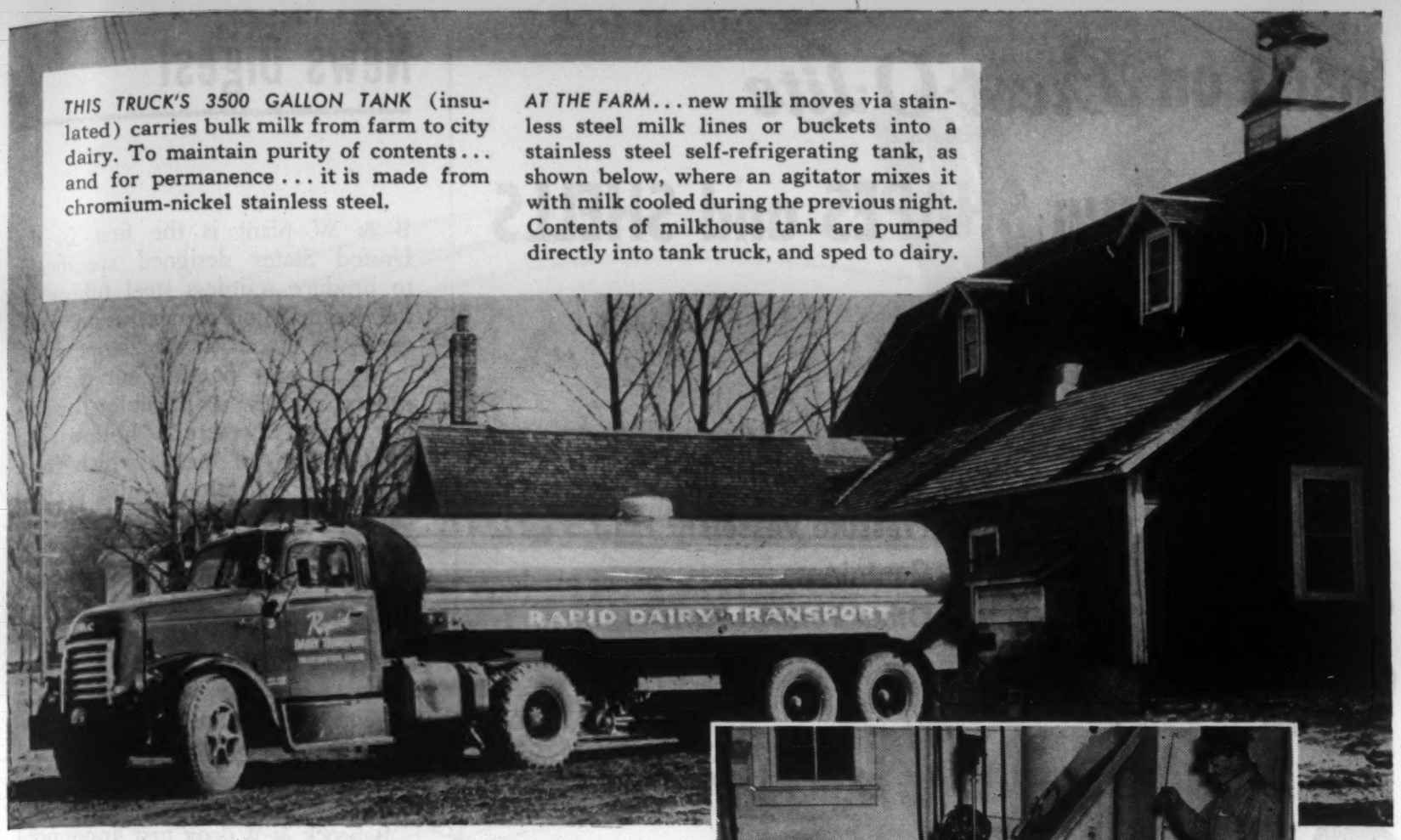
if the gas is trapped in the steel during rapid cooling after firing and later escapes, fishscaling may occur; gas pressure opens scale-like fissures, and in some cases literally blows off flakes of the coating. Until now, the relative importance of the different possible sources of the hydrogen causing the defects has been largely a matter of conjecture. Uncertainty as to the origin of the gas has made the problem difficult to cope with effectively.

A recent National Bureau of Standards investigation, using heavy hydrogen as a tracer, now indicates that water present in the frit (glass) used in the coating is largely to blame for hydrogen-produced defects. Moreover, confirming experiments demonstrate the feasibility of producing a coating free from hydrogen defects by using a water-free frit. Results of the new NBS study, which was undertaken for the National Advisory Committee for Aeronautics by D. G. Moore, Mary A. Mason and W. N. Harrison of NBS staff, should enable manufacturers to produce better porcelain-enameled steel.

Two methods of preparing water-free frit were used in these experiments: drying normally prepared frit by vacuum melting, and preparing frit from dried raw material. Neither lifting nor fishscaling occurred with the vacuum-melted frit, although both these defects were pronounced with the normally prepared frit. Other experiments with reboiling gave confirmatory results. Attempts to prepare defect-free frit from raw materials from which most of the water had been removed were somewhat less successful; some defects developed, though not nearly as many as with the normally prepared frit.

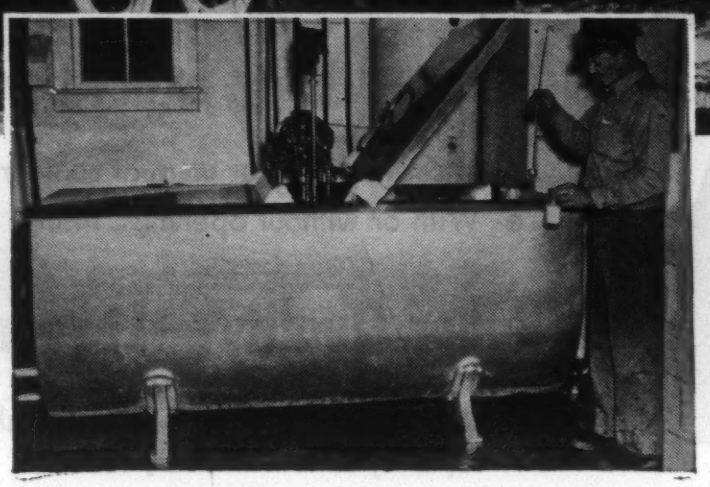
Stainless Steel Tubing Now Produced by Hot Extrusion

Seamless stainless steel tubing was produced on the new hot extrusion facilities of the Tubular Products Div. of The Babcock & Wilcox Co. for the first time in December, according to an announcement made by Luke E. Sawyer, vice president. The announcement revealed that the



THIS TRUCK'S 3500 GALLON TANK (insulated) carries bulk milk from farm to city dairy. To maintain purity of contents... and for permanence... it is made from chromium-nickel stainless steel.

AT THE FARM... new milk moves via stainless steel milk lines or buckets into a stainless steel self-refrigerating tank, as shown below, where an agitator mixes it with milk cooled during the previous night. Contents of milkhouse tank are pumped directly into tank truck, and sped to dairy.



STAINLESS PLAYS IMPORTANT ROLE IN NEW SYSTEM

Of Direct Farm-To-Processor Bulk Handling of Milk!

"Something *new* has been added" to the six billion dollar milk industry...

A *new system*... in which chromium-nickel stainless steel contributes to quicker handling, less drudgery, better cooling, and above all, to higher and more uniform quality of product. Simplicity of the system is shown by the illustrations.

Appreciating its many advantages, United States Steel Company, a leading producer of stainless steels, has supplied these corrosion-resisting metals to many fabricators of milk tank trucks, farm bulk milk tanks and allied equipment.

Austenitic chromium-nickel stainless steels are highly resistant to food acids and atmosphere, as well as to most organic and a great many inorganic chemicals. The mechanical properties of stainless steels permit cutting bulk and deadweight without sacrificing strength or durability. Another all-important advantage is that they are easy to clean, and to keep clean.

Leading steel companies produce austenitic chromium-nickel stainless steels in all commercial forms. A list of sources of supply will be furnished on request.

At the present time, the bulk of the nickel produced is being diverted to defense. Through application to the appropriate authorities, austenitic stainless steels are obtainable for many end uses in defense and defense supporting industries. Counsel and data on alloys containing nickel, for your present production or future projects, are yours for the asking. We invite your inquiries.

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B & W plant is the first in the United States designed specifically to produce stainless steel tubing by the Ugine-Sejournet extrusion process to be placed in actual operation.

Mr. Sawyer pointed out that the process makes it possible for the first time to extrude hollow and solid sections of metals which forge with great difficulty. It also permits much finer and more complicated sections than heretofore possible, even with the more readily forgable steel alloys. He said that the distinguishing feature of this extrusion method of producing seamless tubing is the use of glass to act for an extremely short time both as a lubricant for the hot worked metal and as an insulator to protect the die system.

Babcock & Wilcox first announced its intent to produce tubing by the process in mid-1950 upon the completion of a licensing agreement with Comptoir Industriel d'Etirage & Profilage de Metaux of Paris, France, developers of the process and holders of the patent rights. The first lot of extruded seamless tubing produced at B & W was an 18 chromium, 8% nickel stainless steel alloy, Mr. Sawyer said.

Progress in Aluminum Reported at Association's Annual Meeting

Progress reports on the aluminum industry's expansion program held the spotlight at the annual meeting of the Aluminum Association, held Jan. 22-24 in New York. Current industry problems were discussed in separate sessions conducted by the Association's four active commodity divisions.

Samuel W. Anderson, deputy administrator for aluminum of the Defense Production Administration, Washington, was guest speaker following the Association's annual business session. The expansion program now under way by the industry is on schedule and will be completed next year, he said. Regarding the possibility of the Government's requesting additional aluminum expansion, Mr. Anderson said that no definite plans can be formulated until the needs for de-

The pictured castings are currently being used to produce such important aircraft accessories as fuel injectors and regulators, carburetors, landing gear door latch mechanisms, rocket release mechanisms and radar equipment. Cast to close tolerances with smooth surface finish, expensive machining operations are avoided—resulting in saving of valuable time, reduction in cost and eliminating the need for hard-to-get machine tools. Also *Accumet Precision Investment Castings* permit the use of higher alloyed steels that are difficult or impossible to machine or forge, thus increasing the life or performance of the component parts.

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Crucible engineers and metallurgists are available to assist you in solving your design or production problems by the application of these Accumet Precision Investment Castings . . . that are playing such an important part in our National Defense Program.

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52 years of Fine steelmaking

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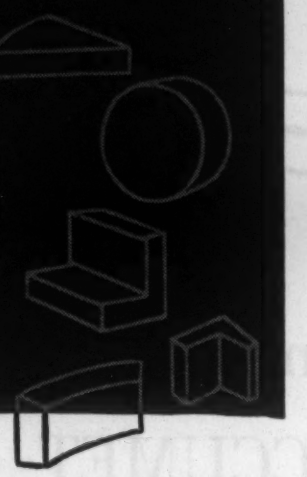

Check the job to be done and you will find a Firecrete* product that will do it well. For special refractory shapes or linings it's simply mix and cast. The new shape or lining air-hardens and is ready for service within 24 hours. Other advantages include—no drying shrinkage, negligible firing shrinkage, high resistance to spalling.

For use up to **3000F — 3X FIRECRETE**

This new member of the Firecrete family effectively withstands soaking temperatures up to a full 3000F. Provides savings through longer life and reduced shutdowns.

For use up to **2800F — H-T FIRECRETE**

A high heat-duty refractory composed of an exceptionally heat-resistant base. Specially developed for service between 2400F and 2800F.

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The most generally applicable type of Firecrete. Finely ground, permitting casting of shapes or linings as thin as 1½".

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A lightweight insulating refractory concrete with unusually low thermal conductivity, low heat storage capacity and high resistance to spalling.

The above Firecrete materials can be used in combination where varying temperature and service conditions are encountered.

For patching and gunning, use 3X BLAZECRETE. For temperatures to 3000F. It has exceptional adherence qualities, can be flipped into place with a trowel without ramming or tamping.

For further information, write to Johns-Manville, Box 290, New York 16, N. Y.

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FIRECRETE

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fense can be projected further into the future.

A. P. Cochran, Cochran Foil Co., Inc., Louisville, was re-elected president of the Association for the ensuing year, and Arthur V. Davis, Aluminum Co. of America, was re-elected chairman of the board. Vice presidents re-elected were: I. T. Bennett, Revere Copper and Brass, Inc., Baltimore; L. M. Brile, Fairmont Aluminum Co., Fairmont, W. Va.; and E. G. Fahlman, The Permold Co., Medina, Ohio. Donald M. White was reappointed secretary-treasurer. Directors elected for three-year terms were: Frank B. Cuff, Aluminum Co. of America, New York; R. G. Farrell, Fairmont Aluminum Co.; and W. A. Singer, Apex Smelting Co., Chicago.

British Metal Finishing Aims Too High, Say Productivity Experts

The British specialist team on metal finishes sent out by the Anglo-American Council on Productivity has submitted its report on American methods. This report is calculated to help British manufacturers increase the productivity of their plants.

The team found that, on the technical side, there was comparatively little which was not already known and practised by the larger and more progressive British firms. To overcome the difficulty of short runs, which impede the general adoption of mechanized methods over there, the possibility of greater specialization should be considered.

British standards of finish impose a considerable handicap on productivity, and the team recommends that, subject to maintaining the durability of the finish, consideration should be given to the adoption of the more utilitarian American standards.

Frequent inspection, often by production personnel, at a very early stage in the manufacturing process is a practice which it is felt should be more widely adopted in the United Kindom.

The opinion is given that metal cleaning and rinsing facilities in many British plating shops are inadequate. The American practice of interposing an alkaline cleaning,

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American supplies special felts for seals. These are ideal materials for bearings, rotating shafts, housings, and similar applications. In many cases, such seals provide lubrication, and no attention is required between major overhauls. Lifetime sealing for ball bearings is another important application. For full information, write for Data Sheet No. 11, "Felt Seals, Their Design and Application." And remember, there are 15 other mechanical functions which felt can perform in your plant or product.

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RCA has developed dozens of different applicators for electronic heating. Ask us about our proved designs . . . chances are there is one already worked out to fit your needs.

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Production of RCA electronic heating units is being stepped up to meet ever-increasing demand. But even so, the supply of completed units for immediate delivery is definitely limited. So if you need electronic heating equipment NOW . . . then NOW is the time to act.

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rinsing and activating cycle between bright nickel and chromium plating is worth investigation in British plants.

Metallurgy in Russian Aviation Industry

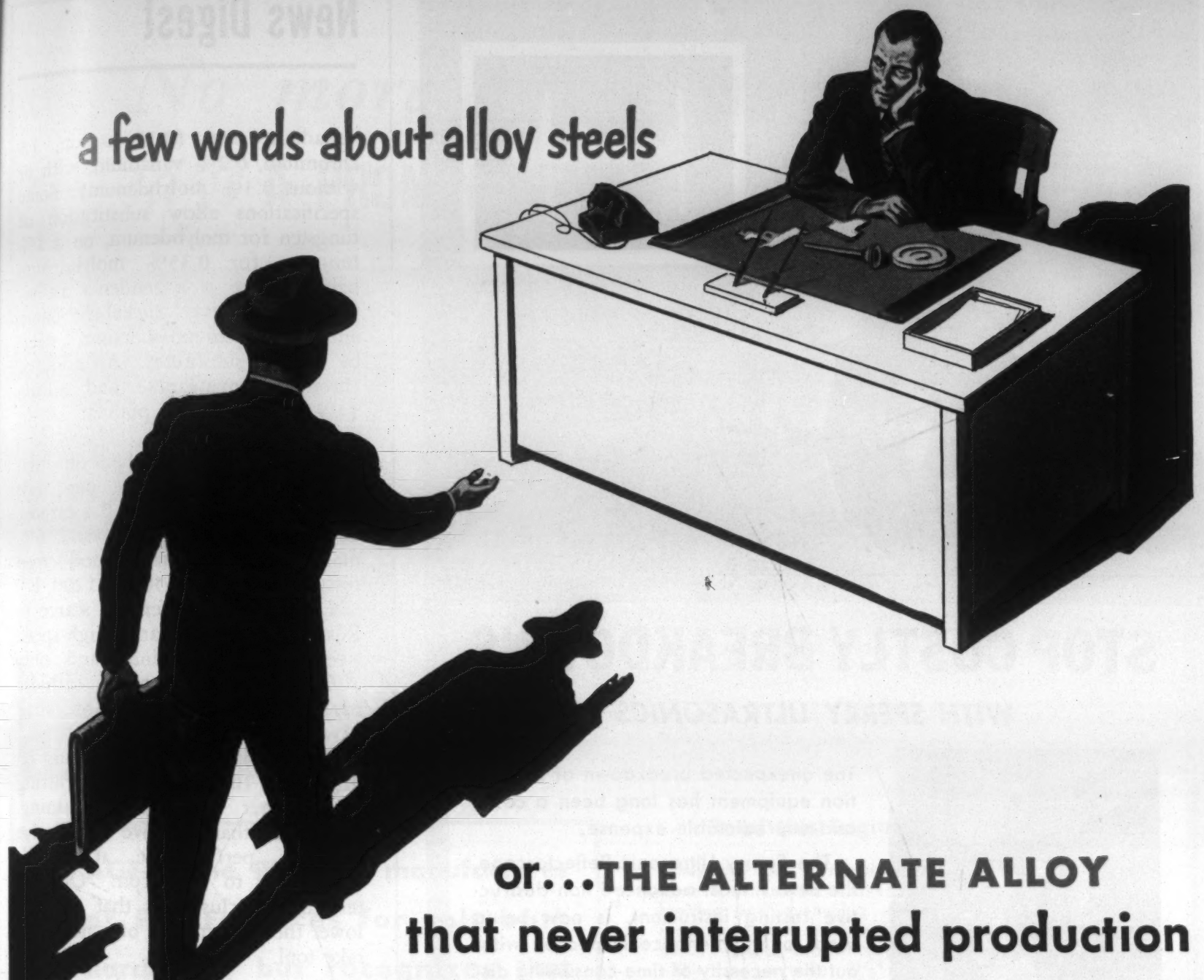
In the December issue of *Aero Digest,* Henry Brutcher surveys the metallurgy and metals in the Russian aviation industry. Mr. Brutcher obtains his information by translating Russian metallurgical publications.

Russian light alloys, both magnesium and aluminum, are almost identical to ours. The alloy contents and mechanical property specifications are based on American and British standards, for the most part. Only one wrought aluminum alloy is claimed to be of Soviet origin. This contains 2.2 copper, 0.65 magnesium, 0.9 silicon and 0.6% manganese. It has the strength of normal duralumin, but is supposed to have better plasticity at high temperatures, and is used for complicated stampings. One of the strongest aluminum alloys shows 70,000 psi tensile strength and 13% elongation after water quenching and 8 hr aging at 347 to 356 F. It contains 4.4 copper, 0.5 magnesium, 0.8 manganese and 0.8% silicon. Another strong alloy has 77,000 psi tensile strength and 10% elongation as an alclad after heat treatment. Without cladding, these valves increase to 85,000 psi and 12%. The alloy content is 1.7 copper, 2.3 magnesium and 6% zinc.

The highest quality Russian special aircraft steels are made in electric furnaces. Induction heating for heat treatment holds a very prominent place in all precision industries. Russian claims to priority may be justified in this field. One interesting method of hardening inner surfaces of small cylinders uses a solid wire inductor (instead of thin walled tube) and is carried out with the coil and cylinder submerged in water.

Russian steel types follow closely Western specifications. Only two low-alloy, high-strength, medium carbon structural steels are made in the USSR. One is a chromium-

a few words about alloy steels



or...THE ALTERNATE ALLOY that never interrupted production

This could happen to you! A customer of ours was forced by restrictions and alloy shortages to switch from the Republic alloy steel he'd been using for years to one of the alternate alloys that he could get. He'd dreaded the problems of redesigning tools and dies, of revising heat-treating procedures, of heavy reject rates while the switch was being made.

But these troubles never came!

He called upon the Republic 3-Dimension Metallurgical Service . . . the Republic Field Metallurgist, backed up by the Republic Mill and Laboratory Metallurgists. These three men worked with the customer's metallurgist and his production foreman. Together, they analyzed his requirements, recommended the best available alternate steel, worked out the way to form the steel and heat-treat it.

The shift was made with almost no interruption, and never a headache.

We may be able to do the same job for you . . . and to back up our recommendation with one of the many fine alloys produced by Republic . . . world's largest producer of alloy and stainless steels.

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Republic REPUBLIC STEEL ALLOY STEELS

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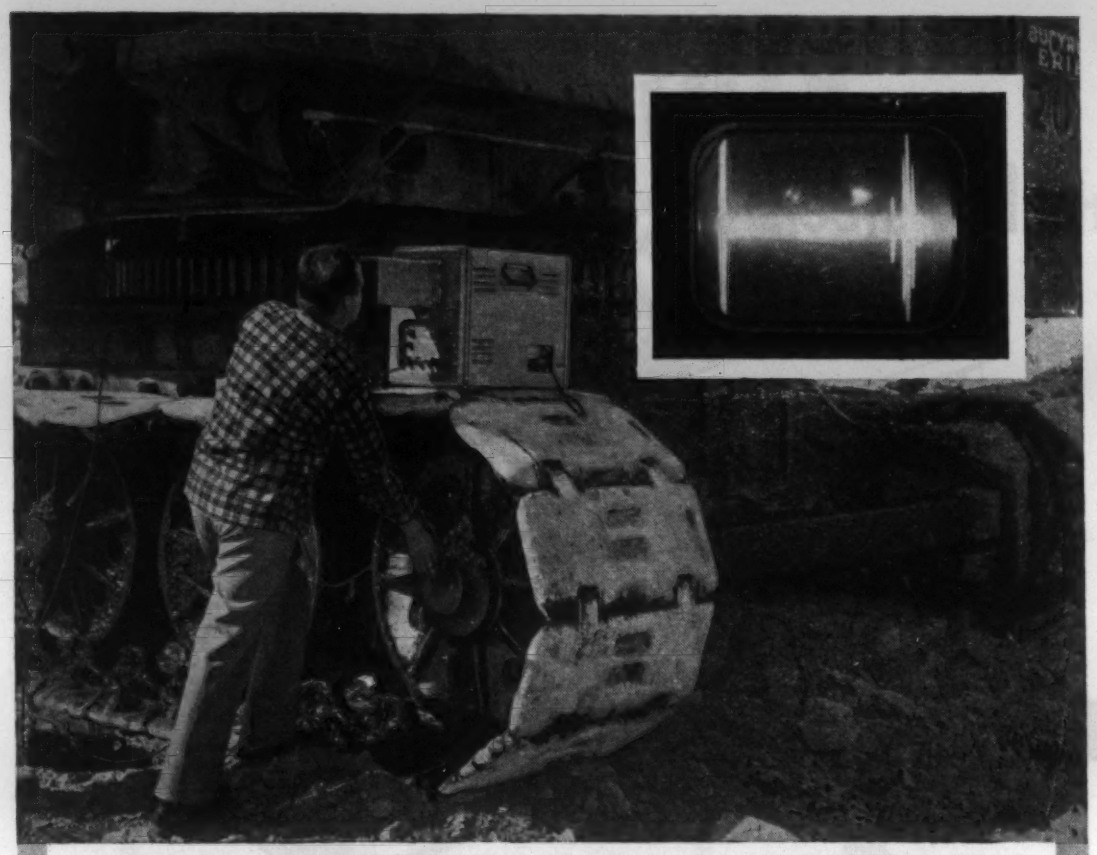
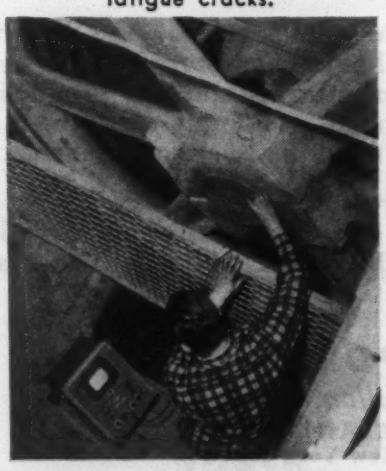


STOP COSTLY BREAKDOWNS

WITH SPERRY ULTRASONICS

Inspecting drill bits for possible fatigue cracks.



Inspecting the main shaft of a 48- by 60-in. jaw crusher.

The unexpected breakdown of production equipment has long been a costly and unpredictable expense.

The Sperry Ultrasonic Reflectoscope, the newest most advanced non-destructive testing instrument, is now being used for maintenance inspection without the necessity of time-consuming dismantling or moving of equipment to special locations.

By testing critical equipment at reasonable intervals, fatigue cracks can be detected and their subsequent growth followed, thus allowing an opportunity to schedule replacement or repair when production is least affected.

Inspections have been made successfuliy for several years on such equipment as—hoisting engine crankshafts and crankpins, sheave axles, hydraulic press cylinders, pressure and back up rolls and in most cases without time losses due to dismantling. Materials and parts produced by equipment such as this are also inspected for defects before vital machining hours are wasted.

Write for complete descriptive information on day to day commercial testing service, lease or sale of the Sperry Ultrasonic Reflectoscope.

Sperry **SPERRY PRODUCTS, INC.**
Danbury, Connecticut

News Digest

vanadium steel (0.35 carbon, 1.0 chromium, 0.2% vanadium, with or without 0.3% molybdenum). Some specifications allow substitution of tungsten for molybdenum, on a 1% tungsten for 0.35% molybdenum basis. There is a tendency to replace expensive nickel-chromium and chromium-molybdenum steels by cheaper substitutes. An alloy of chromium, manganese and silicon (1% of each) is a popular substitute.

Not much is published on high temperature alloys. The one such alloy not used by us is a 0.4 carbon, 18 chromium, 26 nickel and 6% molybdenum steel with good creep resistance up to 1150 to 1200 F.

Cobalt and tungsten are scarce in Russia. The standard high-speed steel has 2.5 vanadium and only 10% tungsten. Sintered carbides based on tungsten carbide or cobalt have been introduced.

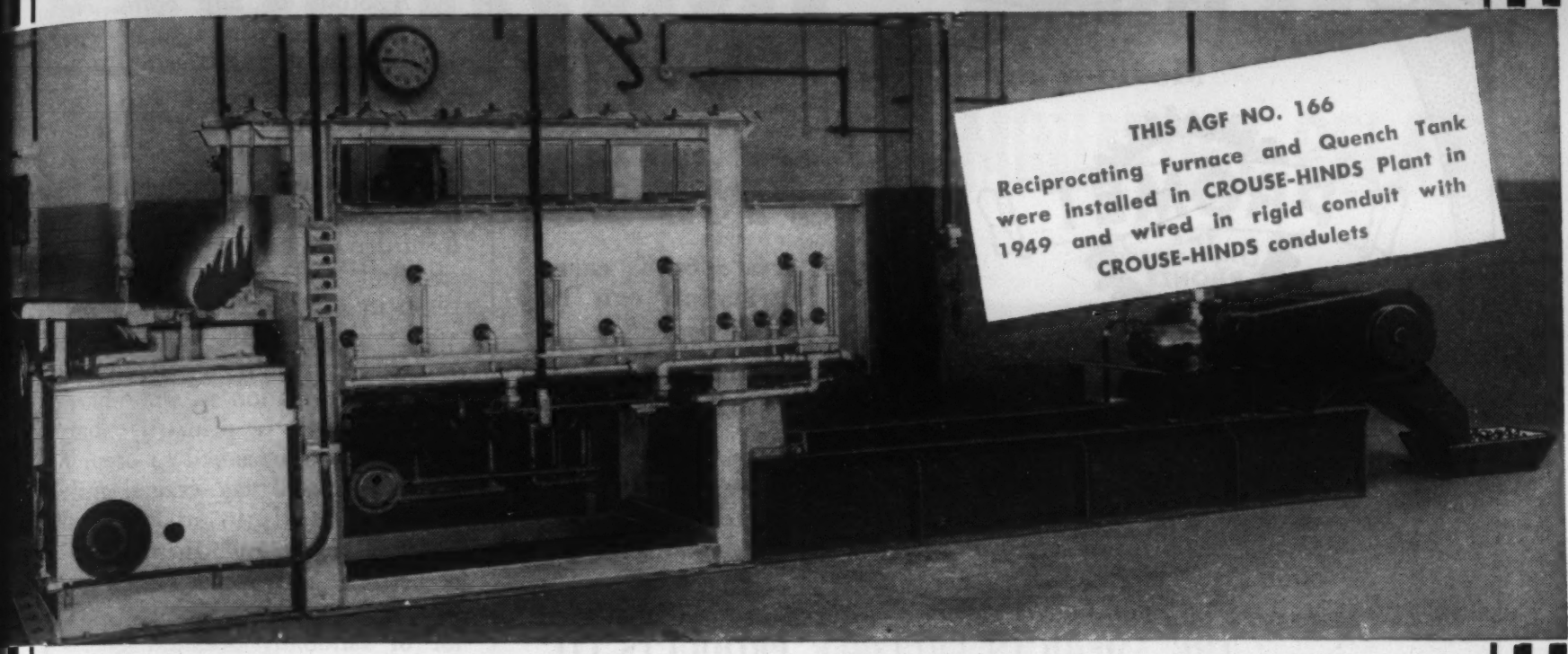
The Russians are concentrating on improving the geometry of cutting tools rather than hot machining. They find that negative rakes give excellent performance at speeds from 1000 to 3000 fpm. One interesting conclusion is that coolants lower the performance of a negative-rake tool.

NACA Publishing Materials Research Reports

The National Advisory Committee for Aeronautics has made reports available on several research projects of interest to materials engineers. Copies of these reports are available from the NACA, 1724 F St., N. W., Washington 25, D. C.

"Ceramic Coatings for Prevention of Carbon Absorption in Four Heat Resistant Alloys." Joseph W. Pitts and Dwight G. Moore, National Bureau of Standards. Dec. 1951. 14 pp. diagr., photos., 3 tabs. (NACA TN 2572). Three ceramic coatings were applied to four heat resistant alloys (three types of 18:8 stainless steel and Inconel) and then tested for their effectiveness in preventing carbon absorption after box carburizing for 4 hr at 1350 to 1650 F. Carbon absorption that occurred on uncoated specimens at these conditions was inhibited by the application of a ceramic coating. The coat-

"No more messy salt baths"
says A PROMINENT INDUSTRIAL ENGINEER



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- No pots to replace
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- No dangerous sputtering or splattering
- Fully sealed muffle
- Low cost of operation
- No messy salt to replace

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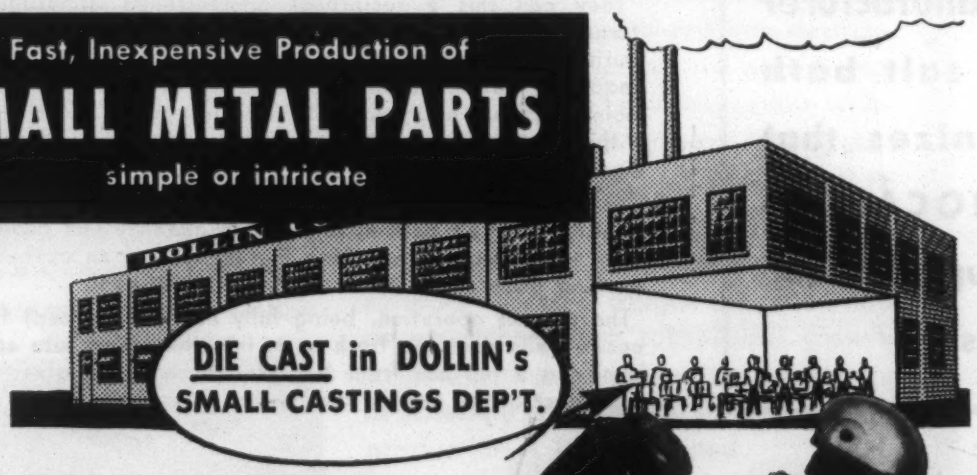

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ing apparently seals the surface of the alloy from carburizing gases and thus prevents carbon pickup and resulting precipitation of carbides at or near the grain boundaries.

"A Study of Slip Formation in Polycrystalline Aluminum." Aldie E. Johnson, Jr. and S. B. Batdorf. Dec. 1951. 18 pp., photos, diagr., tab. (NACA TN 2576). Experimental results are presented which shed light on the assumptions that have been made in several attempts to bridge the gap between the physical and mathematical theories of plasticity. The experimental results are compatible with, but do not necessarily verify, the conception that plastic deformation in strain-hardening materials is primarily due to slip. Slip was observed to occur first in a few isolated grains and to spread gradually to adjacent grains as the stress level increased. The occurrence and spread of the slip lines suggested independent behavior of randomly oriented grains at low stress levels with interaction among grains increasing as the stress level increased.

"On the Angular Distribution of Slip Lines in Polycrystalline Aluminum Alloy." John M. Hedgepeth, S. B. Batdorf and J. Lyell Sanders, Jr. Dec. 1951. 18 pp., photos, diagrs., tab. (NACA TN 2577). A rather wide distribution in the angular orientation of slip lines is generally observed in various grains of a metal subjected to plastic deformation. The relative frequency of occurrence of any given slip line angle for the case of simple tension has been derived on the basis of a model of a plastically deforming polycrystal that was recently used as the basis of a theory of polyaxial stress-strain relations (the so-called slip theory of plasticity). The results are compared with experiment and conclusions are drawn as to the limitations of the model.

"Comparative Corrosion Tests on Magnesium Alloy Parts and Aluminum Alloy Parts of Electrical Equipment in Salt Fog, and Corrosion Tests on Magnesium Alloy Castings in a Humidity Chamber." R. F. Sims and E. C. Railton. Jan. 1951. 11 pp., photos. (RAE Tech. Note El. 20) (Available on loan only.) Comparative tests under severe salt-fog conditions show that corrosion of properly treated magnesium alloys is no worse than that of alumi-

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Edison's new space-saving miniature thermal time-delay relays, scarcely larger than a door key, are built to handle big jobs—accurately and dependably, day in and day out.

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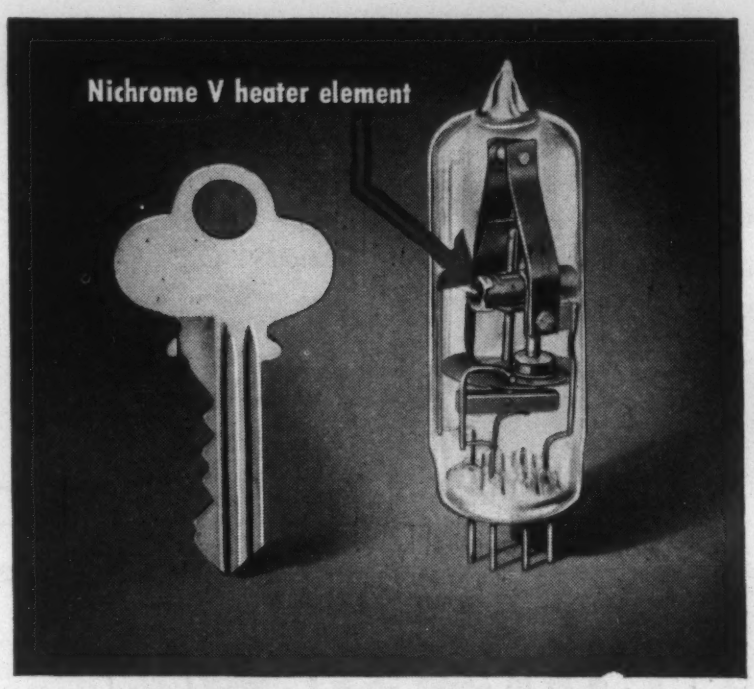

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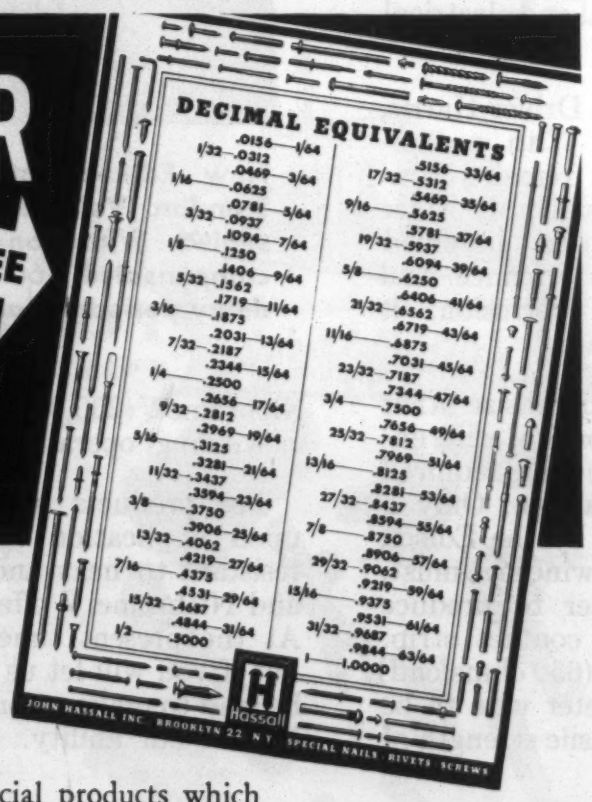

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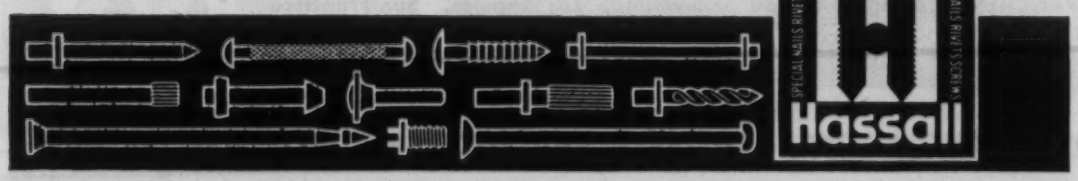


News Digest

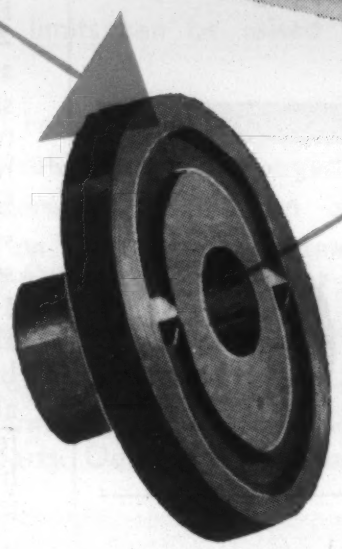
num alloys. Since aluminum has been widely used for parts of electrical equipment in sea-going aircraft, it should be possible to use magnesium alloy parts for similar purposes and so save weight. Points at which other metals contact the magnesium will need careful protection, however, if corrosion is to be avoided.

"Radio Frequency and Other Heating Processes. A Calorimetric Method Assessment of the R. F. Conductivity of Glues." P. M. C. Lacey and G. E. Soane. (Progress Rept. 9) Aug. 1951. 8 pp., diagrs. (Forest Products Research Lab.) (Available on loan only). The radio frequency conductivity of a number of synthetic resin glues has been determined over a wide range of temperature, to an accuracy of about ±15% by a calorimetric method, and compared with the voltages needed to set the same glues in wood joints. It is concluded that conductivity is not a reliable guide to set voltage.

"Graphite Lubrication and the Wear of Carbon Brushes at High Altitudes." R. F. Sims. Apr. 1951. 19 pp., diagrs. (RAE Tech. Note El. 24) (Available on loan only.) The lubricity of graphite in normal atmospheric conditions is shown to be due to absorbed films of water. In dry atmospheres the water films are not maintained, and where graphite brushes are running on commutators, seizure occurs, with resultant high rates of wear. Brushes may be treated with substances, e.g., some metallic halides, which partly replace the water film, but their performance in extremely dry conditions depends critically on previous running of the brush with the commutator in moist conditions.

"Mechanical and Corrosion Tests of Spot-Welded Aluminum Alloys." Fred M. Reinhart, National Bureau of Standards, and W. F. Hess, R. A. Wyant, F. J. Winsor and R. R. Nash, Rensselaer Polytechnic Inst. Dec. 1951. 74 pp., diagrs., photos, 19 tabs. (NACA TN 2538). Corrosion behavior of spot-welded aluminum-alloy (alclad 24S-T3, 24S-T3, alclad XB75S-T6, XB75S-T6, and R-301-T6) panels of varying weld quality was determined. Tidewater and weather exposure tests were made and the results were evaluated largely in terms of distribution of corrosion products and

How would you produce this part?



The part illustrated was made by The Wel-Met Co., Kent, Ohio

It's a small part for a Dictaphone Time-Master Dictating Machine . . . Dictaphone engineers tried machining the figure-8 cam groove and inserting two triangular rise-points. Too costly!

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Stokes engineers . . . designers and builders of the presses on which powder metal parts are made . . . will gladly consult with you on the suitability of your parts for powder metal production . . . or on their re-design to adapt them to this money-saving method.

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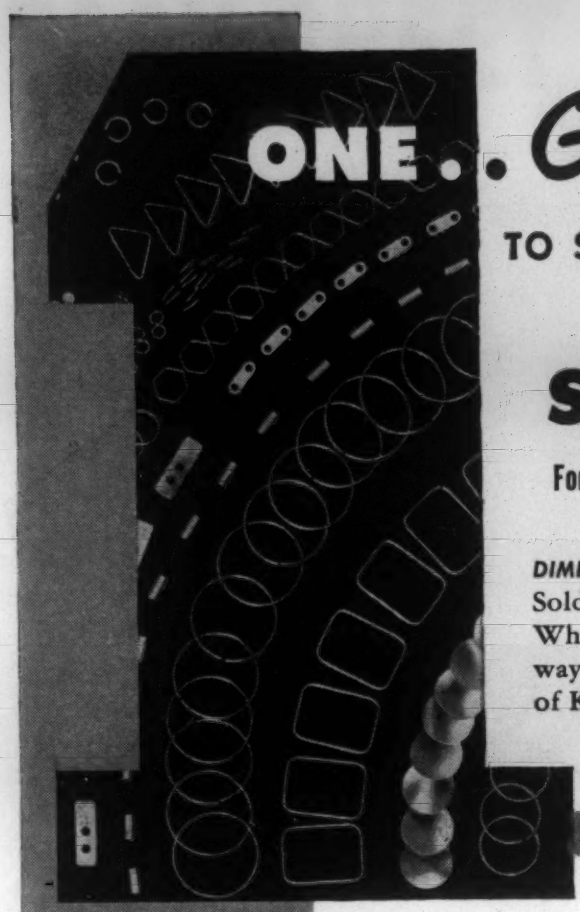

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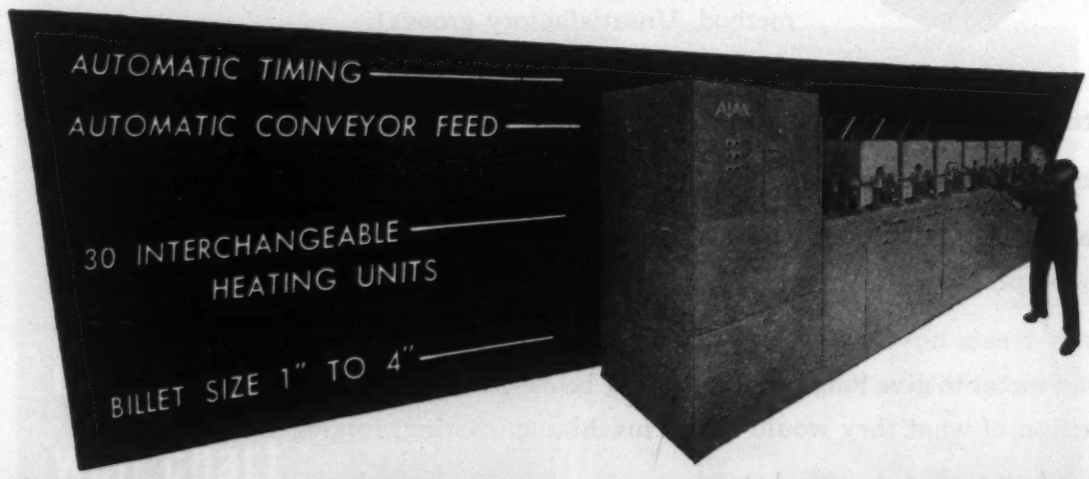

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News Digest

effects on weld strength. Metallographic examinations of several of the alloys were also made to determine the extent and type of corrosion attack associated with various welding and exposure conditions.

"Fundamental Effects of Cold Work on Some Cobalt-Chromium-Nickel-Iron-Base Creep Resistant Alloys." D. N. Frey, J. W. Freeman and A. E. White, University of Michigan. Jan. 1952. 12 pp., diagrs. (NACA TN 2586). The influence of cold working on creep properties of an alloy containing 20% nickel, and the balance iron, and on the same alloy modified by small additions of tungsten alone or tungsten, molybdenum and columbium in combination was studied. Effects of cold working on creep resistance were the same for all alloys studied for temperatures up to 1600 F and reductions between 15 and 40%. Conclusions were reached by studying creep properties and also internal stress relaxation at test temperatures which previous work had shown to be the controlling factor in response of such alloys to cold working.

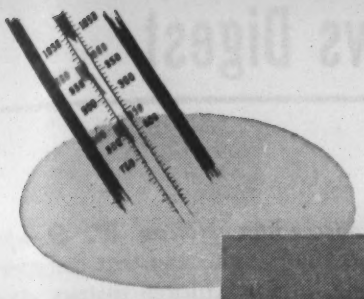
News of Engineers

Appointment of *A. C. Paulson* as manager of the St. Paul Branch, Crucible Steel Co. of America, has been announced by the company.

William H. Funk, who has been associated with the Development Engineering Dept., Lukens Steel Co., since 1945, has been named assistant manager of the department.

The board of directors of The Carborundum Co. recently elected *Clinton F. Robinson* president and director of the company to succeed *H. K. Clark*, who resigned as president. *Paul B. Brown, Clarence E. Hawke* and *William H. Wendel*, formerly managers of the Bonded Products and Grain Div., Refractories Div., and Coated Products Div., respectively, were elected vice presidents in charge of their divisions.

Three personnel appointments at the Cuyahoga Works have been announced by American Steel & Wire Div., U. S. Steel Co. *Walter L. Longnecker* has been named general superintendent of the



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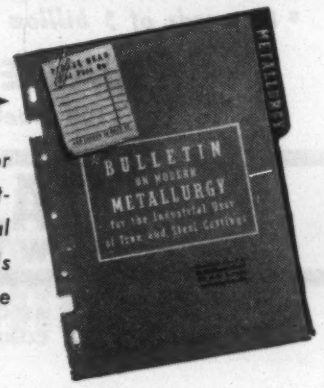

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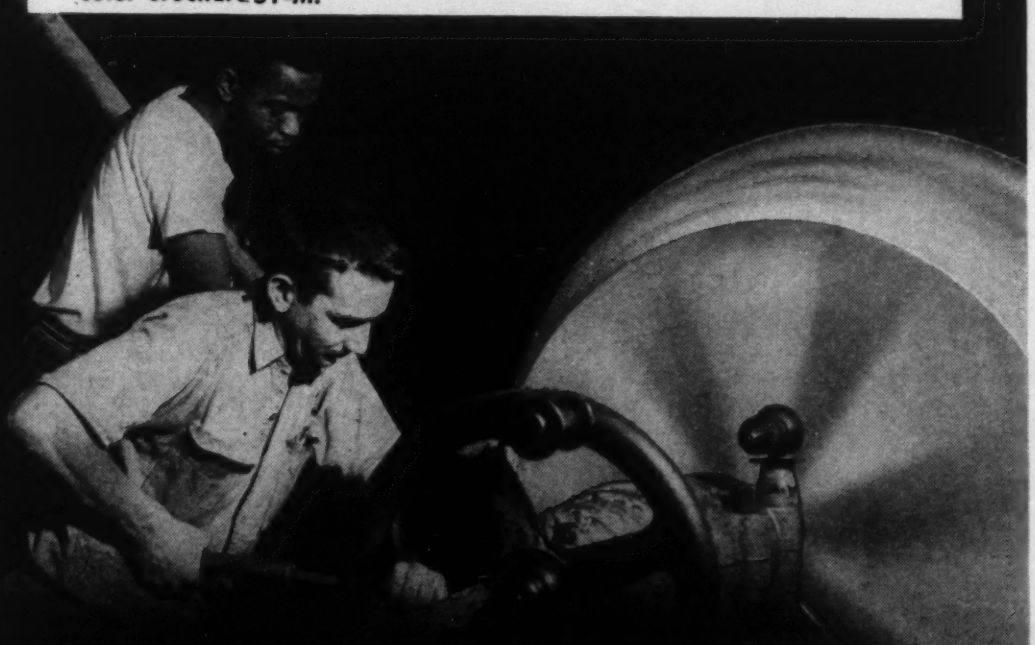

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plant, succeeding *Nelson W. Dempsey,* who recently became assistant manager of operations in the Chicago district. At the same time, *Earle L. Chamberlain* has been appointed division superintendent of the hot mills, succeeding Mr. Longnecker, and *William B. Dawson* has been promoted to Mr. Chamberlain's former post of department superintendent.

The appointment of *C. D. King* as assistant vice president and chairman-engineering committees, United States Steel Co. has been announced, together with the appointment of *J. Donald Rollins* as assistant vice president-engineering.

J. H. King, vice president of the Babcock & Wilcox Co., has been named to head the reorganized Boiler Div. of the company, and *Luke E. Sawyer* and *Edward A. Livingstone,* president and vice president, respectively, of the recently absorbed subsidiary Tube Co., have been elected vice presidents of the Babcock & Wilcox Co. Other appointments within the company include: *M. Nielson* has been named assistant vice president; *Clayton Carl* has been promoted to superintendent of the West Point, Miss. works, and *Adin B. Capron* has been named to the newly created post of chief engineer of the Tubular Products Div.

Olin Industries has announced the appointment of *F. S. Elfred* as executive vice president; *B. E. Bassett,* as vice president for production; and *M. W. Acker,* vice president.

L. J. Carson, former general manager of Link-Belt Co.'s Minneapolis plant, has resigned from his position as price executive of the Machinery Branch of the Industrial Materials and Manufactured Goods Div., O.P.S., Washington, D. C., and has been named general manager of Link-Belt's new Colmar plant.

Charles A. Ebner has been appointed executive vice president, and *Walter E. Jacobson* was named general manager of the Yardley Plastics Co.

Upon the request of *H. H. Doehler,* the board of directors of the Doehler-Jarvis Corp. accepted his resignation as chairman of the board. The directors created a new office of honorary chairman, which has been accepted by Mr. Doehler. *L. A. Jarvis,* formerly president of the company, has been promoted to the office, succeeding Mr. Doehler, and *F. J. Koegler,* formerly executive vice president, is now president of the corporation.

Robert I. Hicks has been elected president and general manager of Lamson Corp. *Carl F. Dietz,* who has been president and general manager since 1938, will continue as president and general manager of the parent company, Lamson Corp. of Delaware, and of its mail tube subsidiaries.

Alan H. Harris has been appointed products manager of the Phosphate Coat-

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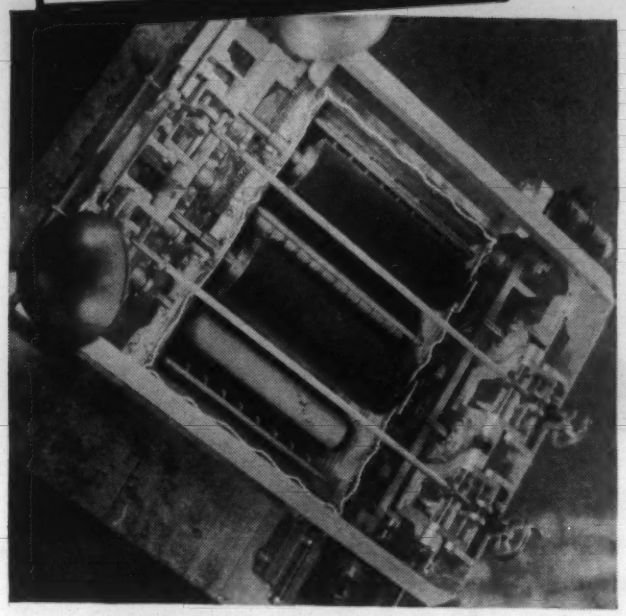

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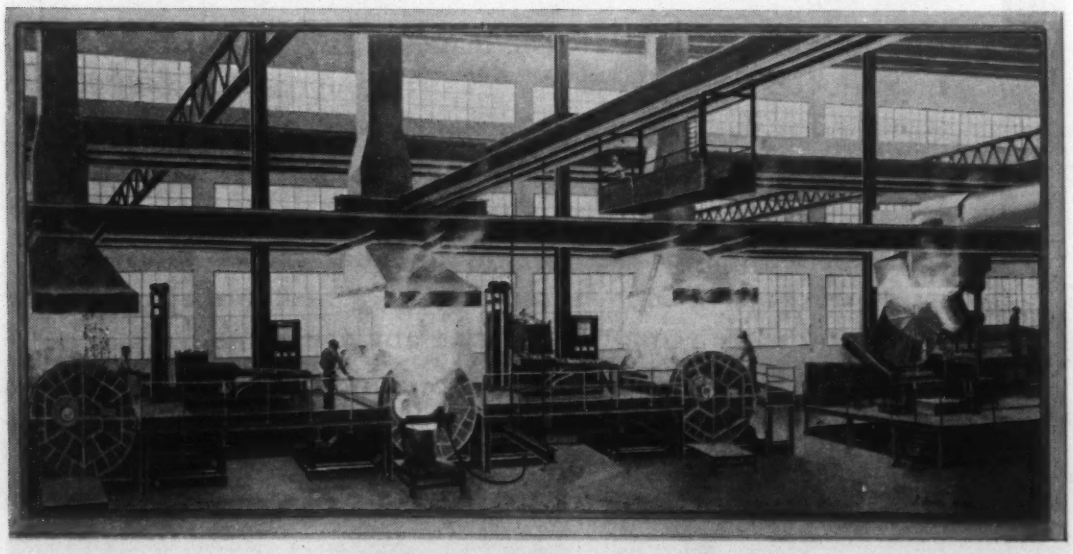

This oil painting, 9 feet long in full color, by J. Gordon White, shows AJAX-SCOMET installation at Scovill Manufacturing Co., Waterbury, Conn.

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AJAX ELECTRIC CO., INC., The Ajax Hultgren Electric Salt Bath Furnace
AJAX ELECTRIC FURNACE CORP., Ajax Wyatt Induction Furnaces for Melting

News Digest

ing Div. for Detrex Corp., according to a recent company announcement.

Edward S. Christiansen, president of the Christiansen Corp., has been named the "Light Metals Man of the Year" by *Modern Metals* magazine. The award is made annually to the individual whose contribution to the light metals field is considered the greatest.

Dr. *Kent R. Van Horn,* one of the nation's leading research metallurgists and an authority on industrial X-ray, has been appointed director of research, Aluminum Co. of America.

Ernest J. Vlad has been appointed a research engineer in the Structural Dept., Armour Research Foundation of Illinois Institute of Technology. Dr. *Herbert M. Meyer,* editor for Engineering Index, Inc., has been named an associate metallurgist in the Metals Research Dept. at the Foundation.

Two major organizational changes in the Naugatuck Chemical Div., U. S. Rubber Co., have been announced. *Clayton F. Ruebensaal,* formerly technical director, plastics and resins, Naugatuck Chemical Div., was named to the newly-created office of commercial development manager, and Dr. *D. Lorin Schoene,* formerly manager of organic research, was named to succeed Mr. Ruebensaal.

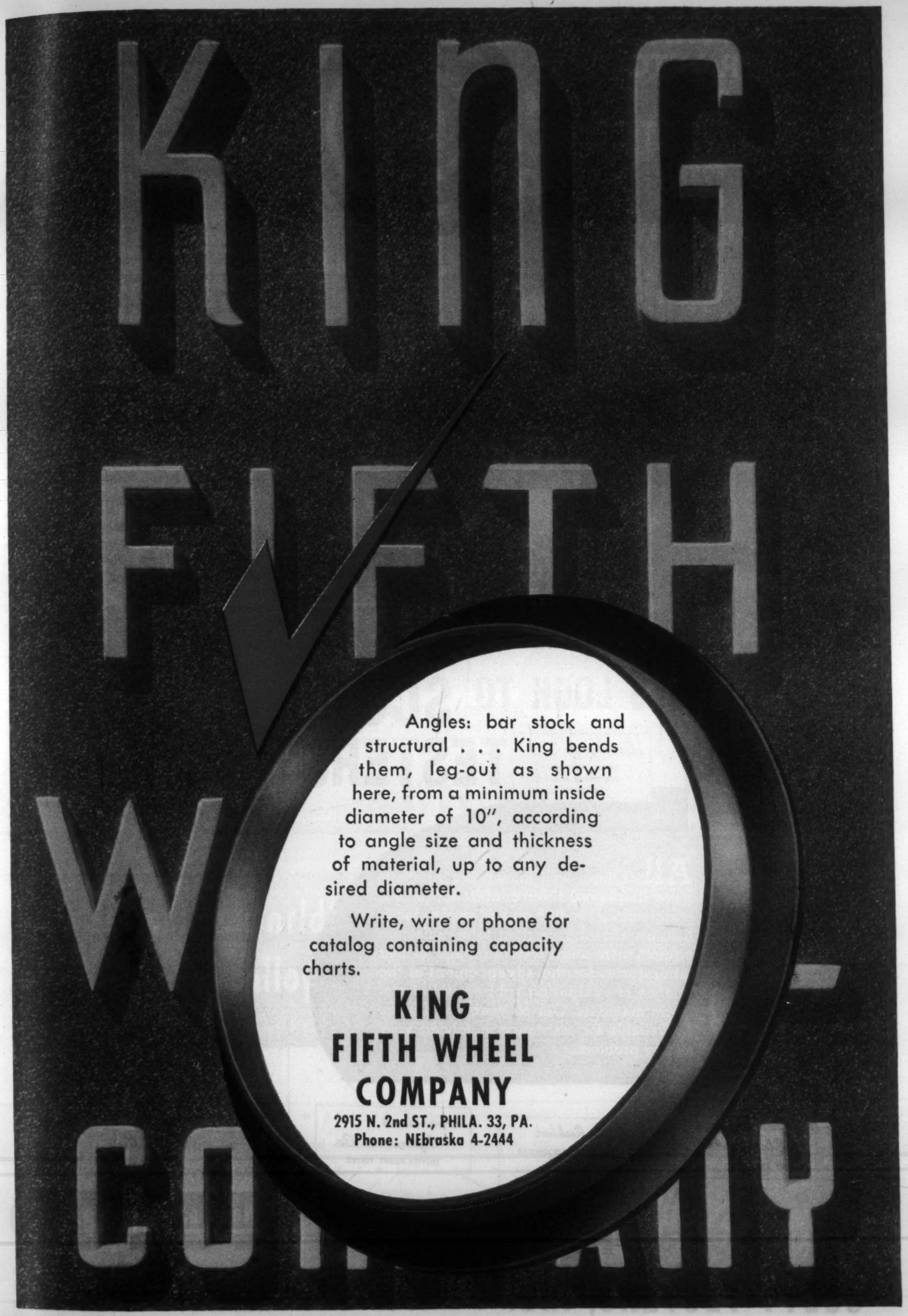
Dr. *William Blum,* internationally known for his contributions to the field of electrochemistry, is retiring as chief of the Electrodeposition Section of the National Bureau of Standards after 42 years of service. Dr. *Abner Brenner* has been appointed to replace Dr. Blum.

For investigating wartime German technical developments, *William C. Heath,* chief design engineer of Solar Aircraft Co., received a citation from Major General *William B. Kean,* commanding general of the III Corps at Fort MacArthur.

D. L. Pastell, of E. I. du Pont de Nemours & Co., Inc., received from the Society of Automotive Engineers the 1950 Horning Memorial Award. The award, presented annually for outstanding contributions to the science of matching fuels and engines, was granted to Mr. Pastell on the basis of the excellence of his technical paper presented at the SAE 1950 summer meeting.

Appointment of two additional vice presidents and a chief engineer at Edwin L. Wiegand Co. has been announced. *Joseph McOrlly,* chief engineer since 1940, is now vice president in charge of engineering, and *Lester D. Drugmand* has been named his successor as chief engineer. *John W. Bailey* was named vice president in charge of industrial relations.

John R. Hoover has been elected president of B. F. Goodrich Chemical Co. Mr. Hoover succeeds *William S. Richardson,* whose increased responsibilities as vice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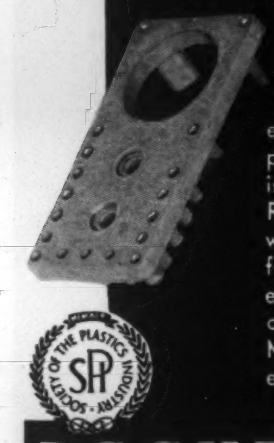

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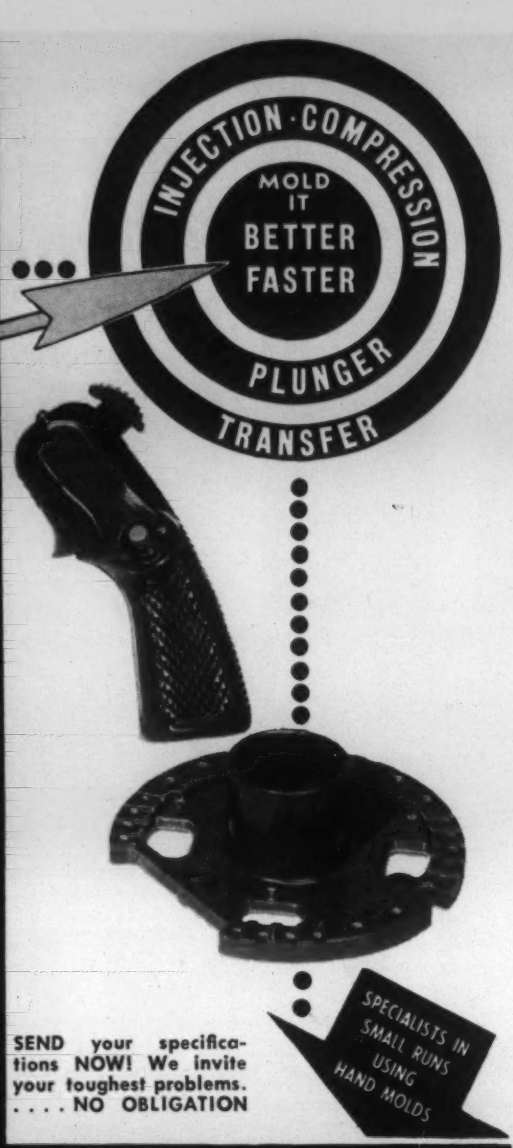

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News Digest

president of the parent company will include the chemical firm.

Roy C. Hauck has been elected vice president in charge of manufacturing and new product planning, Delta Heating Corp.

Charles B. Kentnor, Jr., president, W. S. Rockwell Co., has resigned as president of the Industrial Furnace Manufacturers Assn., Inc. in order to accept appointment as chief of the Industrial Heating Equipment Section, Metalworking Div. of National Production Authority. *J. J. Walker* will assume the duties of the presidency.

Norton Co. has announced the appointment of *Everett M. Hicks* as vice president and director of the company. *Frank W. Smith* retired from the board, but remains a vice president and is being retained as consultant on the company's new machine tool construction project. Two new appointments affecting the company's Research and Development Depts. were also announced. Dr. *Newman W. Thibault* was named chief of a newly formed Physical Research Section of the Research Development Dept., and *Richard E. Englund* became grinding service engineer in charge of the new Grinding Service Section. Norton also announced the retirement of *H. Walter Wagner*, head of the Mechanical Section, Research and Development Dept., after 33 years of service with the company.

Dr. *William Hirschkind*, research director of the Dow Chemical Co.'s Western Div., has been elected technical advisor to the company president.

The Hevi Duty Electric Co. has announced the appointment of *Robert H. Sommers*, formerly chief engineer, as works manager. He has been succeeded by *Arthur W. Frank*, formerly director of research.

United Engineering and Foundry Co. has announced the death of *F. C. Biggert, Jr.*, chairman of the board and one of the pioneers in the design of continuous strip mills for the steel industry.

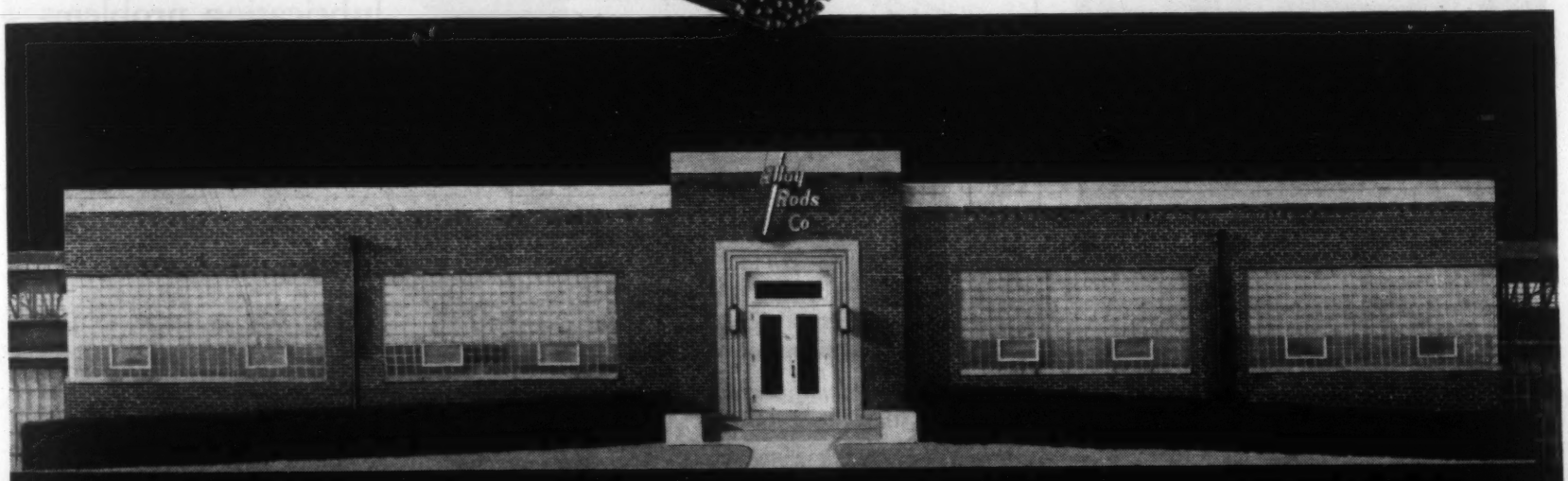
Leeds & Northrup Co. has announced the death of *Morris E. Leeds*, founder of the company and chairman of the board.

News of Companies

The entire executive offices of the *Doehler-Jarvis Corp.*, now located at 386 Fourth Ave., New York, will move to a

Naturally

the world's finest alloy arc welding electrodes*



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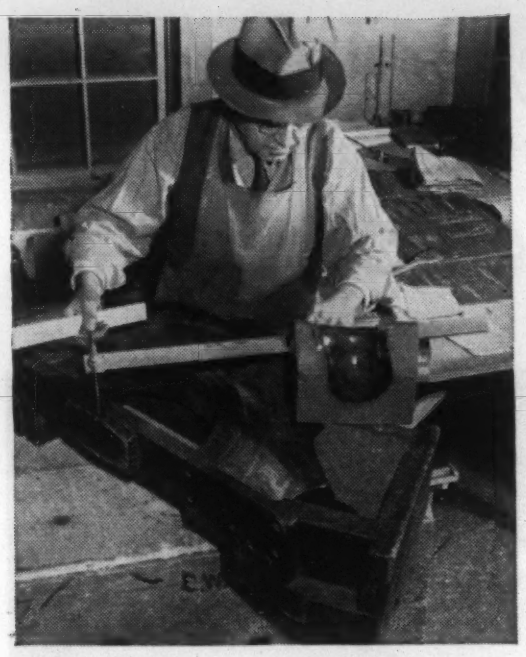

Lebanon Steel Foundry pattern makers study engineering designs, suggest improvements and plan jobs for production giving careful consideration to feed heads, rigging and gating. This care in preparation can save valuable time and eliminate costly failures. Pattern making, however, is but one of many steps in production rigidly followed by Lebanon craftsmen to provide CIRCLE Ⓛ castings of *controlled* high quality.

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Steel and
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News Digest

new office building adjacent to the company's plant in Toledo.

Kaiser Aluminum & Chemical Corp. has announced that it will open a new industry in Nevada by building a mill to process fluorspar, a critical mineral necessary for the production of aluminum metal.

Oakite Products, Inc. have announced the transfer of the company's general offices from 22 Thames St., New York, to new and larger quarters at 19 Rector St., New York 6.

A major expansion of facilities for the manufacture and sale of rubber latex and plastic materials on the West Coast was announced by *Naugatuck Chemical Div., U. S. Rubber Co.* A new plant has been completed on Telegraph Rd., Los Angeles, which will be the division's western sales headquarters. The plant will also contain customer technical service laboratories, and facilities for the compounding and storage of natural and synthetic rubber latex.

The American Agile Corp. has announced the completion of a new 12,500-sq-ft building located at 5461 Dunham Rd., Maple Heights, Ohio. Mailing address, however, is P.O. Box 168, Bedford, Ohio.

Philips Laboratories, Inc. has bought the 44-room mansion and 13-acre estate it has occupied on lease as a research laboratory since 1944. The company plans some necessary improvements to make the buildings more suitable for research and development purposes.

Rockwell Manufacturing Co. has announced the acquisition of the *Deluxe Saw & Tool Co.* and the *Karbide King Tool Corp.*

Construction of a new engineering and development building to be completed within eight months has been announced by *Walter Kidde & Co.* The building will have a floor area of 18,000 sq ft and will double the space presently occupied by the department.

North American Philips Co., Inc. will hold its twelfth X-ray Diffraction School at the company's plant, 750 S. Fulton Ave., Mt. Vernon, N. Y., during the week beginning April 21 through April 25.

American Pullmax Co., Inc. has announced its transfer to new and larger quarters at 2455 N. Sheffield Ave., Chicago 14. The building recently purchased by the company contains 11,000 sq ft of floor space and will house the general offices, display and demonstration rooms, service department and warehouse.

Construction of a new plant in Paris, Tex. by *Babcock & Wilcox Co.* has been announced. The plant is expected to em-

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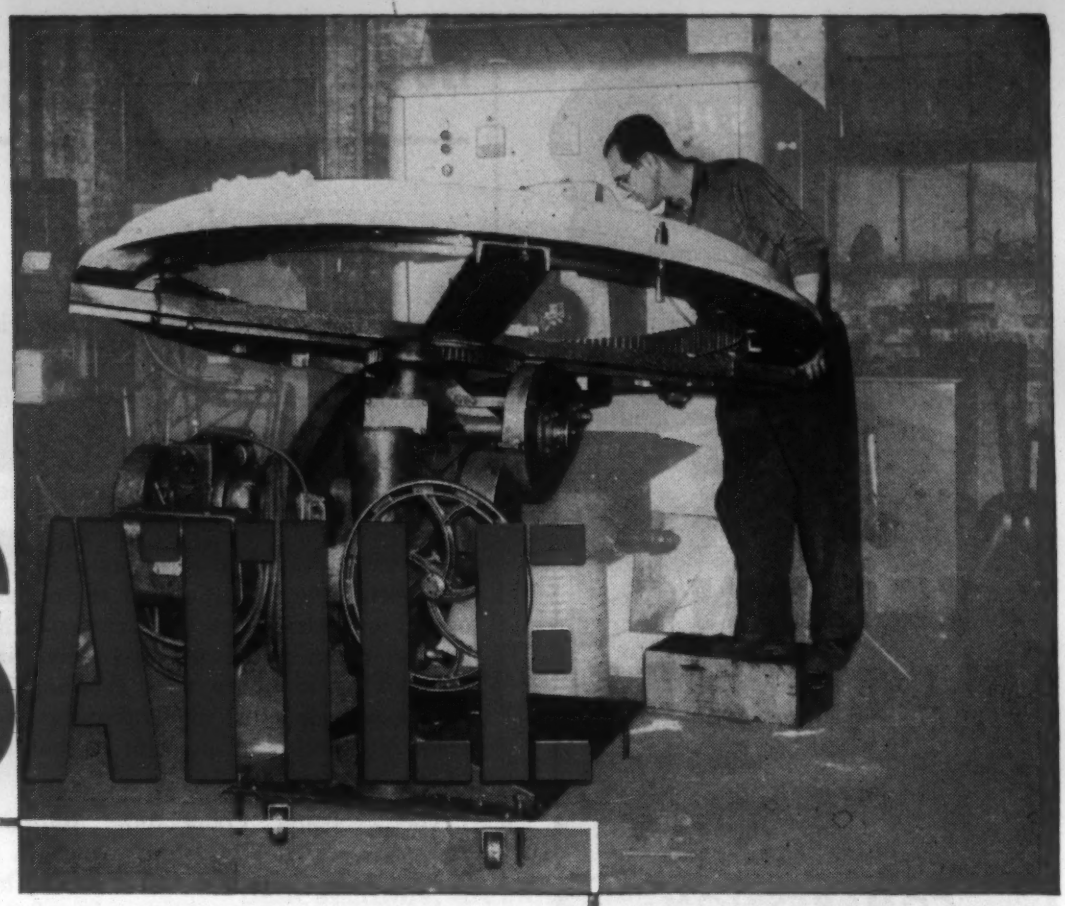
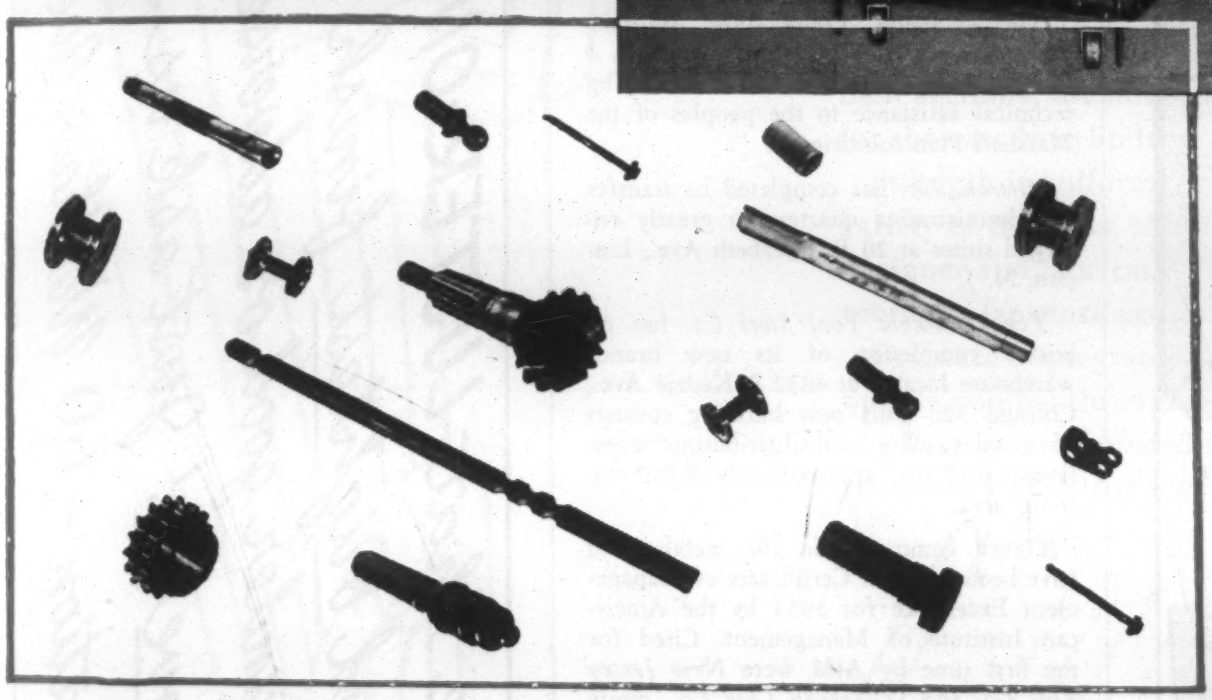


"Internal ring gear being hardened on the Lindberg LI-25 Induction Heating Unit".



Investigate the amazing versatility of the Lindberg Induction Heating Unit—approximately 2000 different parts have been selectively hardened or annealed on this typical commercial heat treating installation.

FROM THE LARGEST—The internal ring gear illustrated above—with a 60″ inside diameter, 3½″ face with 187 teeth each individually heated and oil spray quenched.

TO THE SMALLEST—This small 2″ stamped metal rocker arm was selectively heated and water quenched on the small square face at the rate of 3000 per hour. Investigate this versatile Lindberg Induction Heating Unit—it may supply the answer to your selective heating operations.

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News Digest

ponents for large utility and industrial boilers.

Announcement of a $750,000 expansion program for *Goodyear Tire & Rubber Co.'s* Windsor, Vt., plant has been made. The structure will be used for finished goods, warehousing and shipping.

An extensive plant expansion and improvement program, designed to increase output of refractories products essential to the nation's defense, has been announced by *Robinson Clay Product Co.* The expansion and modernization program is expected to augment current facilities threefold.

The Economic Cooperation Administration has awarded *American Can Co.* a Certificate of Cooperation "for furnishing technical assistance to the peoples of the Marshall Plan countries . . .".

Airtron, Inc. has completed its transfer of administrative quarters to greatly enlarged suites at 20 E. Elizabeth Ave., Linden, N. J.

The Columbia Tool Steel Co. has reported completion of its new branch warehouse located at 4832 S. Kedzie Ave., Chicago 32. This new building consists of a sales office and distributing warehouse, and has approximately 8,000 sq. ft. in area.

Eleven companies in the metals field have been awarded Certificates of Management Excellence for 1951 by the American Institute of Management. Cited for the first time by AIM were *New Jersey Zinc Co.* and *St. Joseph Lead Co.*, while the following were designated "excellently managed" for the second time since the annual award was initiated two years ago: *Aluminum Co. of America; The American Metal Co., Ltd.; International Nickel Co. of Canada, Ltd.; Kennecott Copper Corp.; National Lead Co.; Phelps Dodge Corp.; Union Carbide and Carbon Corp.; The Consolidated Mining & Smelting Co. of Canada, Ltd.;* and *U. S. Smelting, Refining & Mining Co.*

The formulation of a new *General Electric Co.* Chemical Div. product department, to be known as the *Silicone Products Dept.*, has been announced by the company. With the formation of this department, having headquarters in Waterford, N. Y., the G-E Chemical Div. is now made up of four product departments, the other three being Plastics, Chemical Materials, and Laminated and Insulating Products.

American Metallurgical Products Co. will move its manufacturing facilities from Hays, Pa. to Newcastle, Pa., according to a recent company announcement. The new plant, which will have four times the operating capacity of the old one, will be used for the production of metallurgical silicon carbides, with ade-

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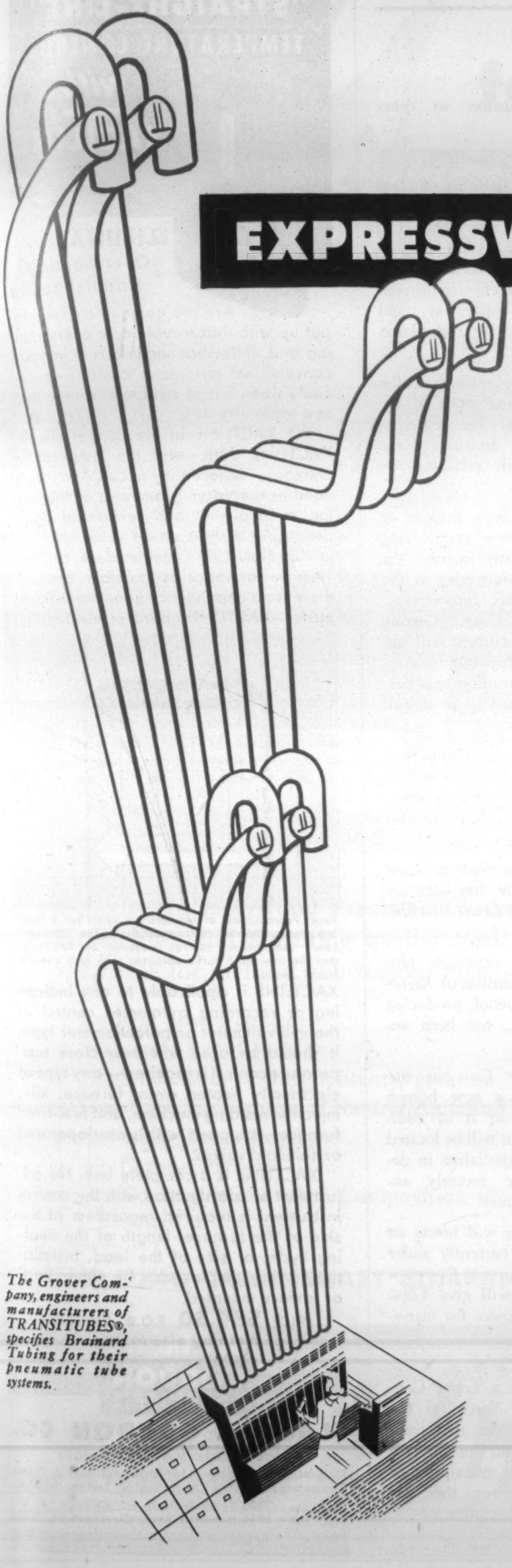
another job for **Brainard** TUBING



The Grover Company, engineers and manufacturers of TRANSITUBES®, specifies Brainard Tubing for their pneumatic tube systems.

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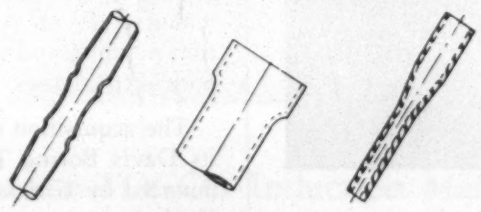
● Precision is important in pneumatic tube systems . . . a big reason why Brainard Electric-welded Tubing is so widely used for this application.

Brainard Tubing is produced to close tolerances, with a smooth inside finish. In straight or bent sections, the bore is a smooth expressway for the carrier cylinders.

Strength is uniform. Sections can be joined by a variety of methods, simplifying the work of both designer and fabricator. And . . . electric-welded tubing is far more economical than other types.

Brainard's integrated production facilities assure quality control throughout manufacture . . . from ore to finished tubing. Depend on Brainard service for *your* needs.



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Brainard tubing is a uniform product made to close tolerances. Has good machining qualities and finish can be supplied as specified. Easily fabricated—can be beaded, expanded, swaged, spun, flanged, upset, grooved, fluted, flattened, tapered, and otherwise formed. Supplied straight or fabricated, sizes ½″ to 4″ O.D.; .025 to .180 gage.

Fast delivery on certain sizes. For further information or catalog, write Brainard Steel Division, Dept. X-4, Griswold Street, Warren, Ohio.

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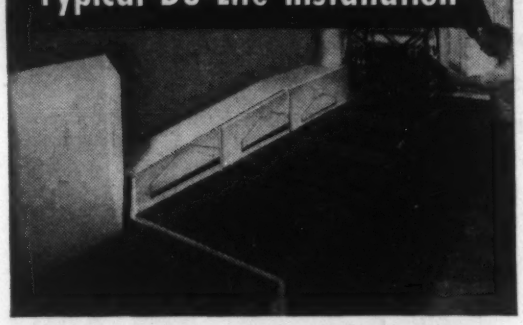
Du-Lite gave this part with its complicated knurls, slots, threads, etc. a fine rust-resistant durable black finish. It is typical of many other parts, small and large, which have been black oxidized by Du-Lite for many years. Moreover, Du-Lite meets most individual and government specifications including 57-0-2C for Type III Black Oxide finish.

Typical Du-Lite installation



Du-Lite installations are simple, compact, easy to operate. Du-Lite equipment can be tailored to fit production requirements on all types of jobs with a maximum of speed and economy. Du-Lite also makes a complete line of cleaners, strippers, wetting agents, passivating agents, rust preventatives, burnishing compounds etc. for any metal finishing application.

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METAL FINISHING SPECIALISTS

News Digest

quate space for expansion to other operations.

Dow Corning Corp. will invest over $13,000,000 in a major expansion of plant capacity for its silicone products, according to a recent company statement. The expansion is designed to assure an adequate supply of silicone materials to the armed services and to defense industries. Construction is already underway, and the program is scheduled for completion by 1954.

Mueller Brass Co. has announced the purchase of all outstanding stock of the *Valley Metal Products Co.* The new subsidiary will operate as a division of the parent company although retaining its own name of VAMPCO.

Ground has recently been broken to start the construction of new graphitizing facilities which will greatly increase the production of graphite electrodes at the Niagara Falls plant of *International Graphite and Electrode Corp.* Costing $10,000,000, the new facilities will include a calciner, 16 graphitizing furnaces and complete milling, extruding and baking facilities. It is expected to be in full production by May, 1953.

Electronic Rubber Co. has announced that it is expanding its facilities to include manufacture of polyvinyl chloride injection molding and extrusion compounds for nonelectrical uses.

The acquisition of a new plant to house its Davis Boring Tool Div. has been announced by *Giddings and Lewis Machine Tool Co.*

Receipt of a necessity certificate providing $1,475,000 for expansion of *Reichhold Chemicals', Inc.,* phenol producing plant in Tuscaloosa, Ala., has been announced by the company.

Cyril Bath Machinery Co. has announced construction of a new branch plant comprising 50,000 sq ft of additional space. The new plant will be located at Solon, Ohio, and will specialize in defense production of the recently announced Rotary Draw Former.

New construction which will house an enlarged machine shop is currently under way at the *McDanel Refractory Porcelain Co.* The two-story plant will give 4,000 more square feet of floor space for manufacturing operations.

Kaiser Aluminum & Chemicals Corp. has announced signing of a Letter Contract with the U. S. Air Force for the construction of facilities on the company's Newark, Ohio, plant site for two gigantic forging presses to mass-produce aluminum aircraft parts for the Air Force's airframe and engine contractors.

Greatly expanded production of mag-

Automatic
"STRAIGHT-LINE"
TEMPERATURE CONTROL
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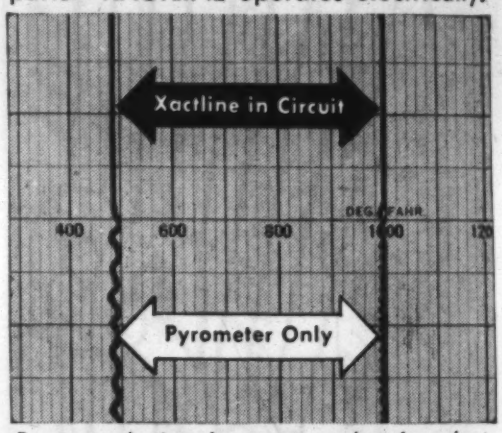
ELIMINATE
Overshooting
Undershooting

Are you going to continue to put up with that troublesome overshooting and undershooting inherent in your conventional pyrometer control—especially when it is so easy to eliminate that saw-tooth effect?

Put XACTLINE in the control circuit. XACTLINE anticipates the temperature changes—before they occur. And too, it nullifies the varying amounts of thermal lag, residual heat, and mechanical lag—producing a short on-off cycle resulting in "Straight-Line" temperature control. This performance is possible because there is no dependence upon mechanical parts—XACTLINE operates electrically.



Exact reproduction of temperature chart for a heating process showing the comparison of the "Straight-Line" temperature control produced by XACTLINE and the saw-tooth curve obtained with only conventional control.

XACTLINE is applicable to any indicating or recording pyrometer control of the millivoltmeter or potentiometer type. It should be used wherever close temperature control is required—any type of electrically heated oven, furnace, kiln, injection molding machine, and fuel-fired furnaces equipped with motor-operated or solenoid valves.

XACTLINE is a complete unit. No adjustment or coordination with the control instrument is required regardless of the size of the furnace, length of the heating cycle, or size of the load. Installation is very simple—can be either flush or surface mounted.

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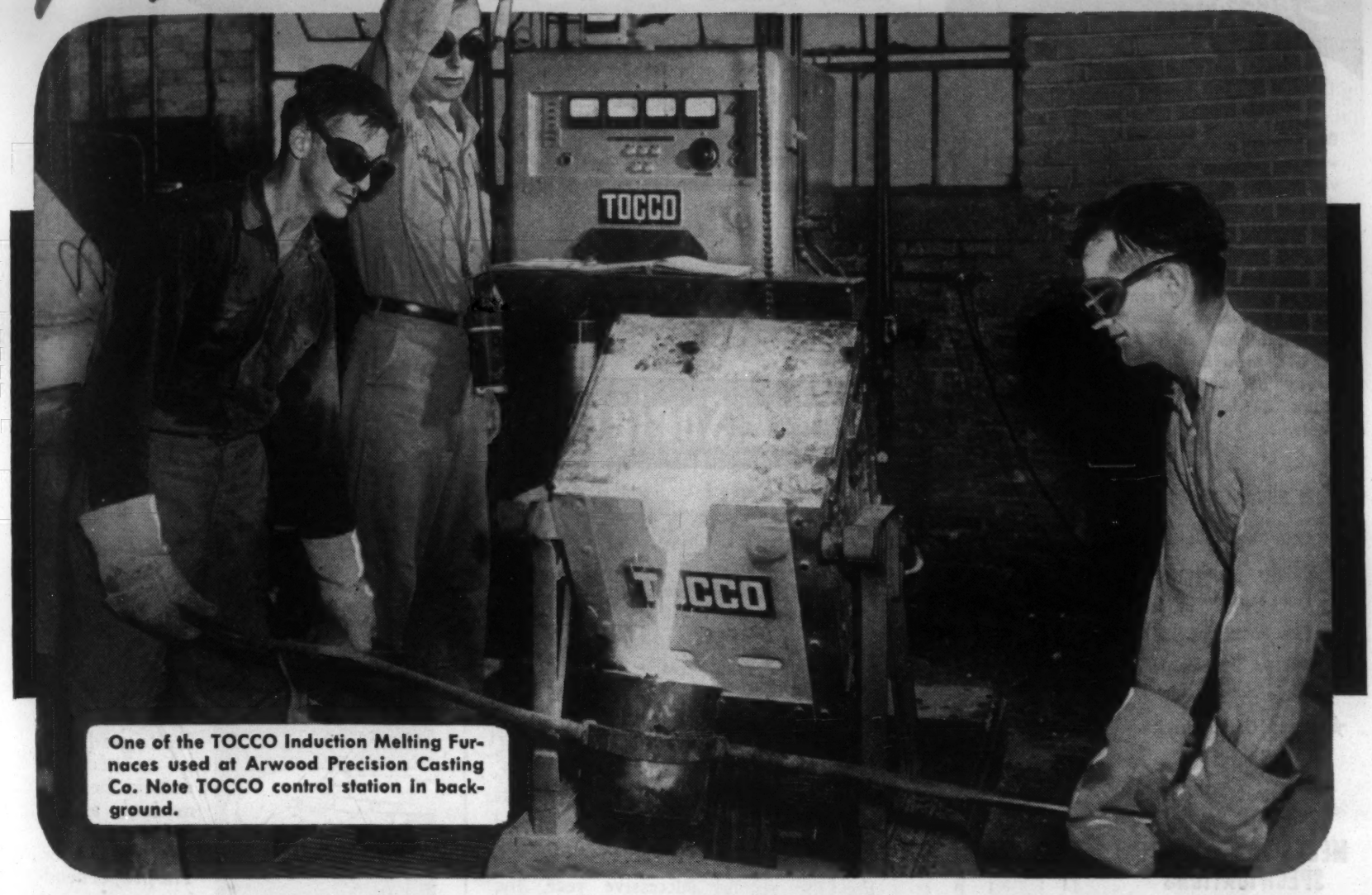
TOCCO* Induction Melting Furnaces for Precision Casting



One of the TOCCO Induction Melting Furnaces used at Arwood Precision Casting Co. Note TOCCO control station in background.

● Engineers at Arwood Precision Casting Co. use TOCCO Induction Melting Furnaces for melting and remelting quality steel. Other companies have found TOCCO equally adaptable for melting non-ferrous metals. No wonder! *Look at the advantages:*

- ★ Stepless power control
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- ★ Good Mixing because of Natural Agitation
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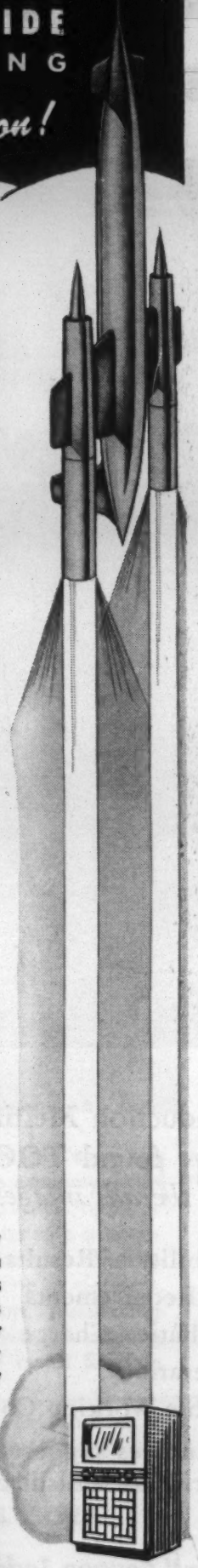

BLACK MAGIC — whether applied to civilian or defense production — has proved to be a versatile, economical finish. Its ability to blacken heat treated parts or previously "hard to blacken" items has established **BLACK MAGIC** as a finish capable of exceeding black oxide requirements.

Other advantages are:

- ★ One Bath—One Salt
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News Digest

nesium and aluminum castings will be achieved when the *Castalloy Co.* starts foundry operations at its new plant, located on West Central St., Natick, Mass. According to the company, the plant will have a monthly capacity of 60,000 lb of finished castings.

The opening of a Dayton Branch at 1534 Keystone Ave., of the *J. N. Fauver Co., Inc.,* has been announced.

News of Societies

Two significant lectures are in prospect for the Fiftieth Anniversary Meeting of the *American Society for Testing Materials,* to be held in New York City during the week of June 23, 1952. Dr. R. C. McMaster, Battelle Memorial Institute, will deliver the 26th Edgar Marburg Lecture on the subject Non-Destructive Testing. The first H. W. Gillett Memorial Lecture is to be given by N. L. Mochel, manager, Metallurgical Engineering, Westinghouse Electric Corp. Mr. Mochel has selected the subject, "Man, Metals and Power."

For the second successive year, the National Production Authority has drafted the president of the *American Society of Tool Engineers* to help work out solutions to industrial bottlenecks. J. J. Demuth, 1951-52 president of the Society, has been appointed chief of the Tool, Die, Jig & Fixture Section, Metal-Working Equipment Div., Washington, D. C.

The College of Engineering, State University of Iowa, announces the 13th summer management course to be held June 9 through June 21, 1952, in Iowa City.

Dr. Berton S. Clark, scientific director of American Can Co.'s Research and Technical Dept., has been appointed chairman of the *Can Manufacturers Institute Research Committee* for 1952. This committee is responsible for research on technical problems of industry-wide importance.

A new technical *Committee D-23 on Cellulose and Cellulose Derivatives* has been organized by the *American Society for Testing Materials.* Immediate objectives of the group are study and formulation of standard methods of tests, specifications and definitions of terms. Temporary officers are: Chairman, F. A. Simmonds, U. S. Forest Products Lab.; and secretary, W. W. Becker, Hercules Powder Co.

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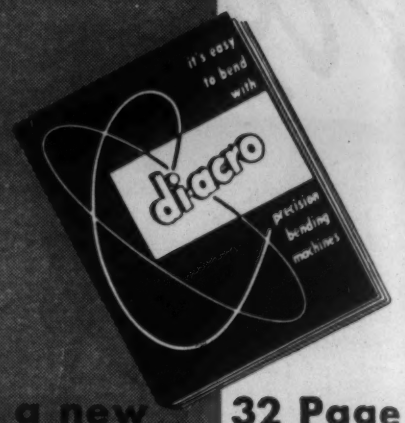

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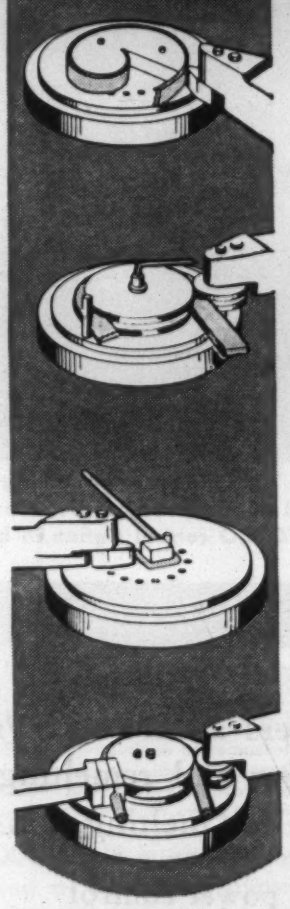

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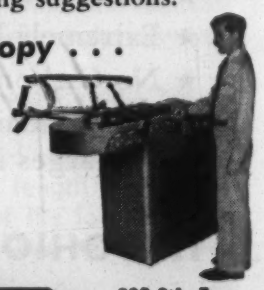

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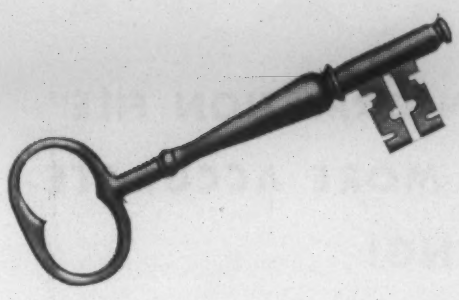

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Meetings and Expositions

ANNUAL WELDING CONFERENCE. Detroit. Apr. 16-18, 1952.

LEAD INDUSTRIES ASSOCIATION, annual meeting. Chicago. Apr. 18-19, 1952.

AMERICAN ZINC INSTITUTE, annual meeting. St. Louis. Apr. 21-22, 1952:

SOCIETY OF AUTOMOTIVE ENGINEERS, national aeronautical meeting. New York. Apr. 21-24, 1952.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Institute of Metals Div., New England regional conference. Boston. Apr. 25-26, 1952.

AMERICAN CERAMIC SOCIETY, annual meeting. Pittsburgh. Apr. 27-May 1, 1952.

ASSOCIATION OF IRON & STEEL ENGINEERS, spring conference. Cincinnati. Apr. 28-29, 1952.

METAL POWDER ASSOCIATION, annual meeting and exhibit. Chicago. Apr. 29-30, 1952.

AMERICAN FOUNDRYMEN'S SOCIETY, annual convention. Atlantic City, N. J. May 1-7, 1952.

NON-FERROUS FOUNDERS' SOCIETY, annual meeting. Atlantic City, N. J. May 1-7, 1952.

ELECTROCHEMICAL SOCIETY, golden jubilee meeting. Philadelphia. May 4-8, 1952.

NATIONAL WELDING SUPPLY ASSOCIATION, annual convention. Chicago. May 4-7, 1952.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION, international lighting exposition and conference. Cleveland. May 6-9, 1952.

SCIENTIFIC APPARATUS MAKERS' ASSOCIATION, annual meeting. Chicago. May 6-9, 1952.

NATIONAL SCREW MACHINE PRODUCTS ASSOCIATION, national meeting. St. Louis. May 7-10, 1952.

INDUSTRIAL FURNACE MANUFACTURERS ASSOCIATION, annual meeting. Hot Springs, Va. May 11-14, 1952.

SOCIETY FOR EXPERIMENTAL STRESS ANALYSIS, spring meeting. Indianapolis. May 14-16, 1952.

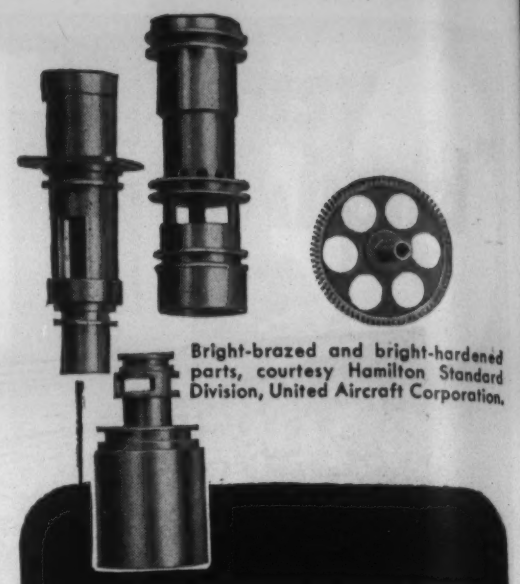
COPPER & BRASS RESEARCH ASSOCIATION, annual meeting. Hot Springs, Va. May 18-21, 1952.

NUCLEAR ENERGY CONFERENCE. East Lansing, Mich. May 20-21, 1952.

AMERICAN IRON & STEEL INSTITUTE, general meeting. New York. May 21-22, 1952.

AMERICAN SOCIETY FOR QUALITY CONTROL, annual convention. Syracuse. May 22-24, 1952.

SOCIETY OF AUTOMOTIVE ENGINEERS, summer meeting. Atlantic City, N. J. June 1-6, 1952.



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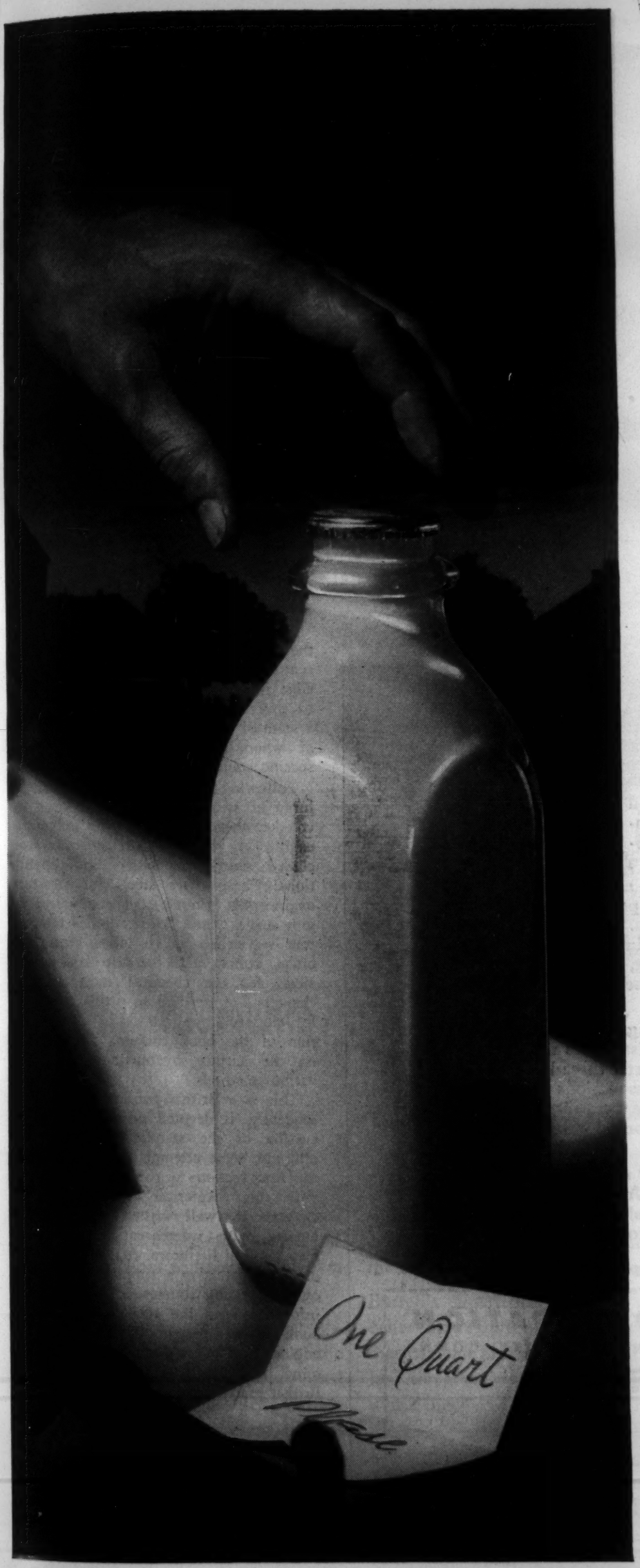

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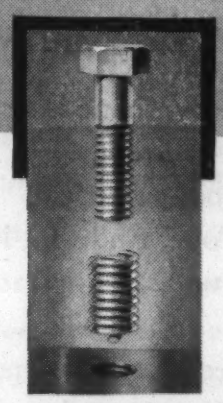

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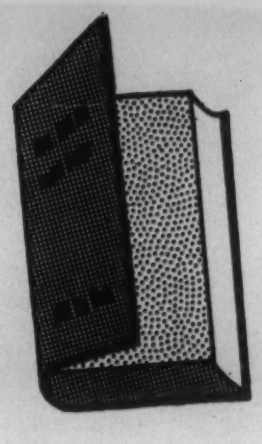

BOOK REVIEWS

Steels in Modern Industry

STEELS IN MODERN INDUSTRY. *Edited by W. E. Benbow. Published by Iliffe & Sons, Ltd. London S. E. 1, England, 1951. Cloth 5½ by 8¾ in., 562 pages. Price 42s.*

In his foreword Dr. Gough states that the book was planned "to obtain and concentrate the widest available expert knowledge in the various fields it was desired to cover." To accomplish this objective, a team of 29 experts was assembled, each of whom contributed a chapter on a specific subject.

Following a brief section on the metallurgy of steel and a second section devoted to the general properties influencing engineering design, 13 chapters are included which deal with specific applications. These cover steels for structural engineering, aircraft and automotive engine steels, materials for elevated temperature service in gas turbines, steam turbines, boilers and pressure vessels, and steels for the chemical industry. Four chapters are devoted to steels developed for electrical applications. The final section of the book contains five chapters on the surface treatment of steels by various methods.

This is a British publication and, consequently, is devoted primarily to a discussion of the standard British steels, although some attempt has been made in the first section to compare these steels with their American equivalents. The chapters are well written and are documented with references to world-wide metallurgical literature. A feature of many of the chapters is a supplementary bibliography listing sources of more detailed information on the subject matter. This book has been prepared with the materials engineer rather than the metallurgist in mind, and is an excellent summary of British practice.

Other New Books

TREATISE ON MILLING AND MILLING MACHINES. *Published by The Cincinnati Milling Machine Co., Cincinnati 9, Ohio, 1951. Cloth,*

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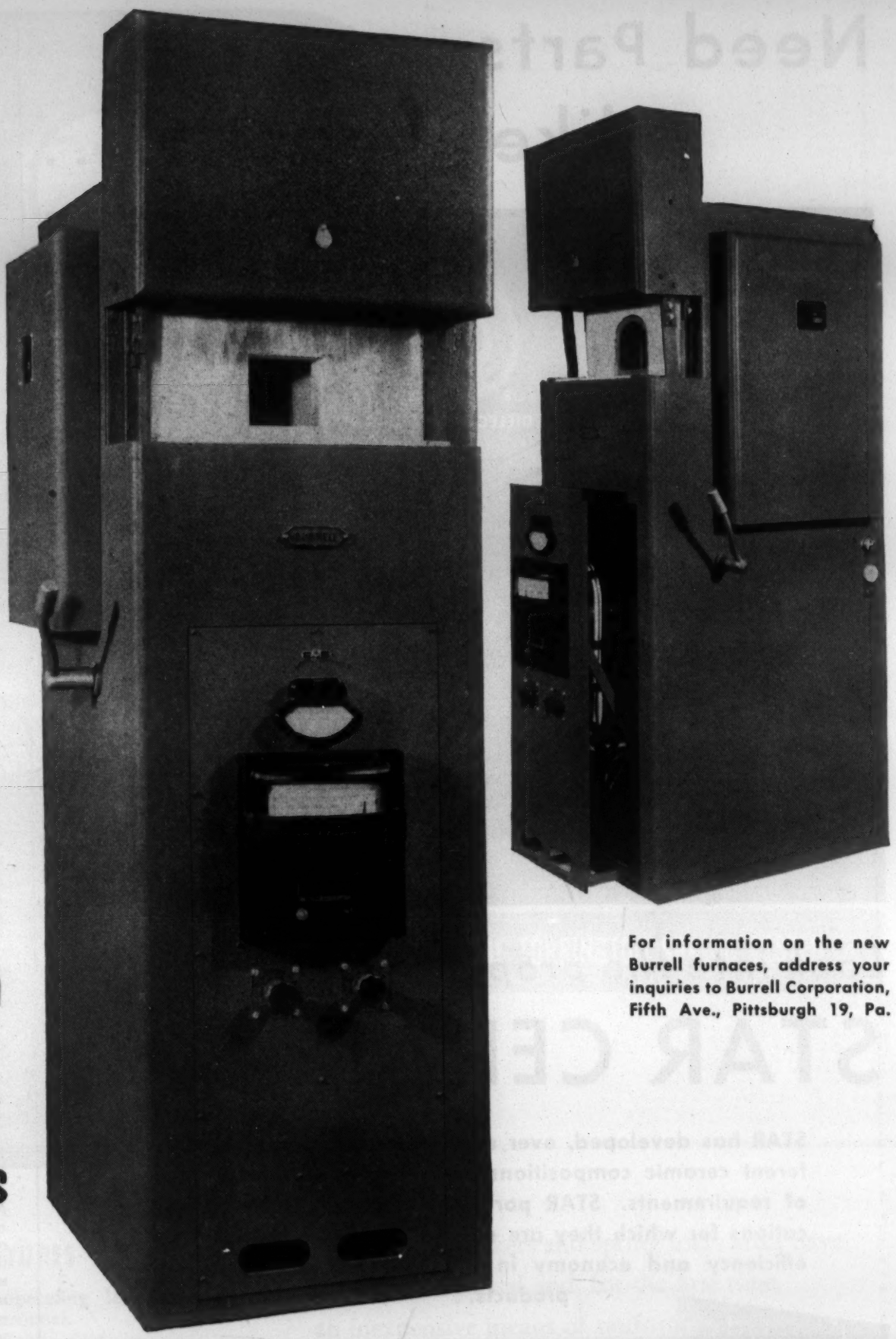

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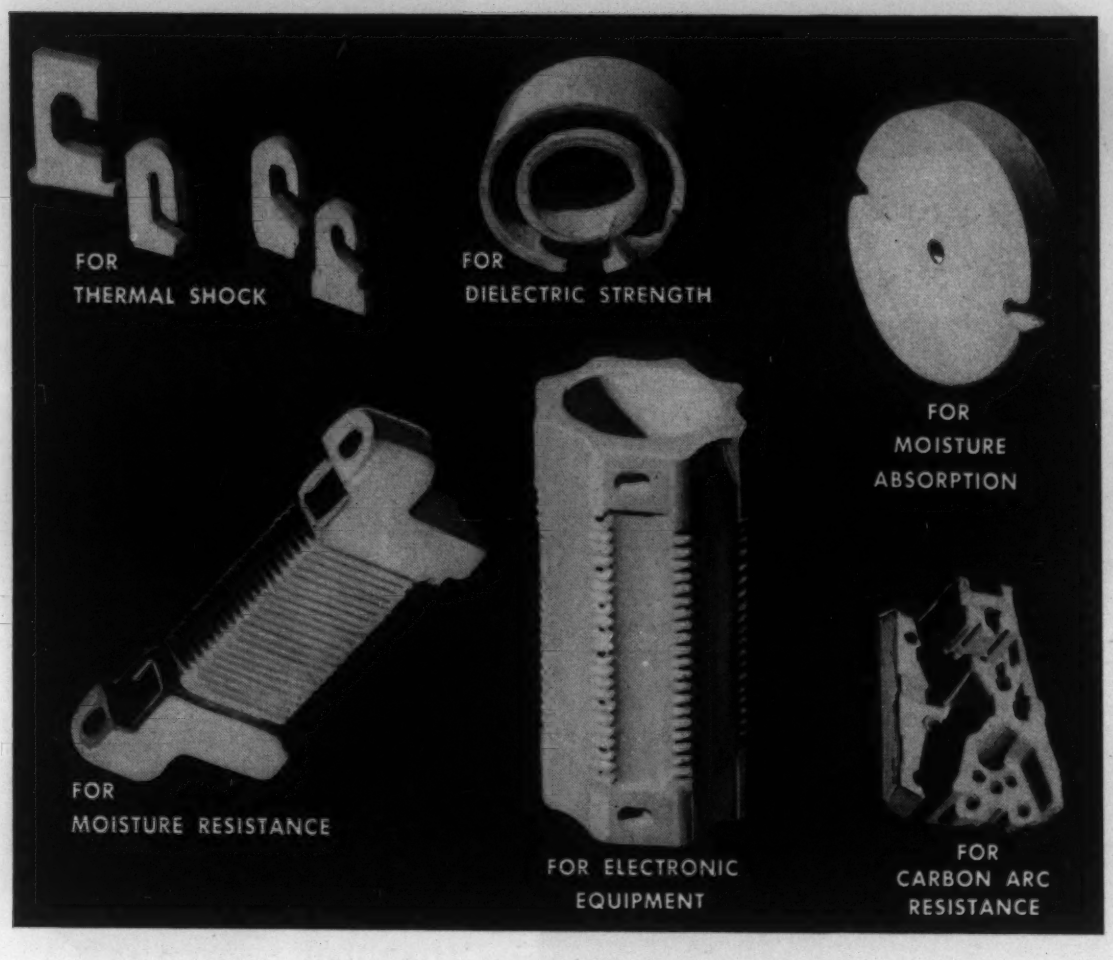

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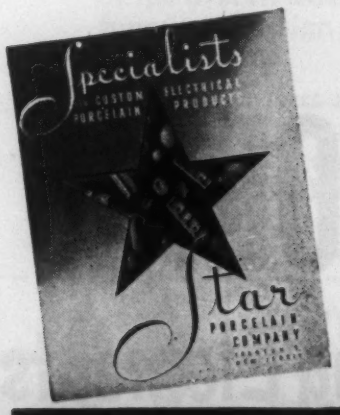

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Book Reviews

(continued)

6¼ by 9¼ in., 896 pages. Price, $8.00. This book thoroughly covers the theory and practice of metal cutting by the milling process, and related subjects such as toolroom milling set-ups, fixture design, and others.

A Basic Training Manual on Statistical Quality Control. *By Rudolph Freedman and Joseph Movshin, in cooperation with the Industrial Engineering Dept., Washington University. Published by the St. Louis Society for Quality Control, St. Louis 5, Mo., 1951. Price, $2.50; 10 or more copies, $2.00.* This manual has been written for use in short elementary courses in statistical quality control. It may also be used in conjunction with plant training, short courses given by technical societies, and a standard text on quality control in a full course. An instructor's guide is available upon request at no extra charge with each order of 10 or more copies.

Buckling Strength of Metal Structures. *By Freidrich Bleich. Published by McGraw-Hill Book Co., New York 36, N. Y., 1952. Cloth, 508 pages. Price $10.00.* The author, the late Freidrich Bleich, worked in close cooperation with the Navy's David Taylor Model Basin (Bureau of Ships), the staff of Frankland & Lienhard, and the Column Research Council in developing this reference volume of tables and simplified, approximate formulae and methods relating to the behavior of fabricated steel structures under compression loading. Commander Lyle B. Ramsey, USN, collaborated, and the book was edited by Hans H. Bleich, associate professor of civil engineering, Columbia University.

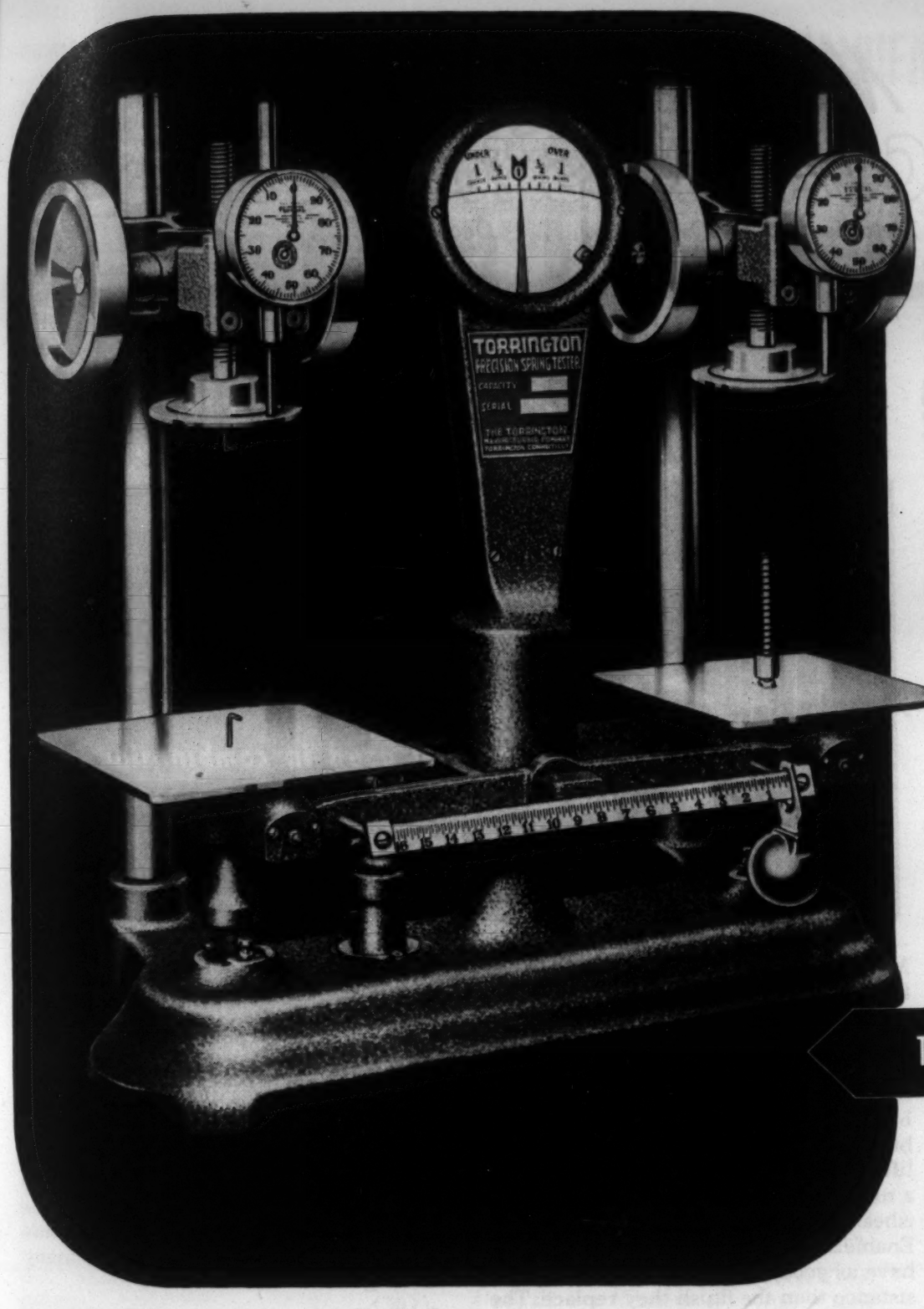
Practical Surface Tension Secrets for Platers. *By Joseph B. Kushner. Published by Electroplating School, Stroudsburg, Pa., 1951. Mimeographed pamphlet, 8⅞ by 11½ in., 9 pages. Free of charge to members of the metal finishing industry when requested on company letterhead.* Principles of surface tension, references and suppliers are included in this compact pamphlet.

Inspection and Gaging. *By C. W. Kennedy. Published by The Industrial Press, New York 12, N. Y., 1951. Cloth, 6¼ by 9¼ in., 502 pages. Price $7.50.* A comprehensive training manual and reference work that discusses the place of inspection in industry today, describes the types of automatic and manual gaging and measuring devices employed, shows the proper techniques of using inspection equipment, and outlines the specific duties of inspection personnel.

The Grinding Wheel. *By Kenneth B. Lewis. Published by Grinding Wheel Institute, Greendale, Mass., 1951. Cloth, 6¼ by 9¼ in., 409 pages. Price, $3.50.* A textbook prepared to give a reader a solid grounding in the fundamentals of abrasive technology, and assurance to step out and begin to build on that foundation.

Finite Deformation of an Elastic Solid. *By Francis D. Murnaghan. Published by John Wiley & Sons, Inc., New York 16, N. Y., 1951. Cloth, 6 by 9¼ in., 140 pages. Price $4.00.* A clear, authoritative exposition of a subject that is rapidly growing in importance in the whole field of engineering.

Elements of Ceramics. *By F. H. Norton. Published by Addison-Wesley Press, Inc., Cambridge 42, Mass., 1952. Cloth, 7½ by 9¾ in., 246 pages. Price $6.50.* This book is designed to cover the principles underlying the various processes used in the ceramic field, with enough illustrations to make their application clear. Rather than discussing products, the emphasis is placed on unit processes.



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Many of today's successful substitute finishes are *combination* finishes – retaining the eye-appealing advantage of a bright plate and using the corrosion resistance of modern organic coatings. Metal finishers have several such combinations from which to choose to get a bright finish with satisfactory service life. Laboratory tests, in fact, show that a number of substitute bright plated finishes protected with Unichrome Clear Enamels, Varnishes or Lacquers actually have as good, if not better, corrosion resistance than the finish they replace. The extra protection provided by the Unichrome Clear Coating compensates for that lost with deposits that are different or thinner than usual.

TIME-TESTED COMBINATION FINISHES

Zinc Plate of 0.0002" to 0.0005" thickness, when chromate-treated in Unichrome Clear Dip, can provide a finish that matches chromium for brightness. Corrosion resistant in itself, this outstanding substitute finish has been used for years with a clear enamel on shelves for quality refrigerators. For this particular interior application, Unichrome Clear Coating B-132 provides excellent protection against acids, alkalies, grease, moisture. In most other applications, Unichrome Clear Coating B-115 supplies the extra durability. It resists humidity, handling, discoloration, abrasion and has established itself as the ideal, all-around protector against corrosion of plated finishes.

Chromium, deposited from the Unichrome S.R.H.S. Bath directly on steel or on a copper undercoat, is being followed up by many finishers with baked-on Unichrome Coating B-172 or B-115 for the adhesion, clarity, and resistance to corrosion and outdoor exposure that these clear coatings display.

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Bright Metals such as stainless steel and bright passivated zinc plate can be made to simulate gold or brass colors with an application of Unichrome Coating B-165 – Gold or Brass-Tinted. This lightfast, synthetic is used on both interior and exterior trim of refrigerator parts. It has excellent resistance to humidity, discoloration and corrosion. Similar coatings available for application to chromium.

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MICHIGAN LIBRARIES

MANUFACTURERS' LITERATURE

numerous applications how they are used. (50)

Precision Castings. Alloy Precision Casting Co., 8 pp, ill. Describes frozen mercury process for close tolerance precision casting of parts to order. Shows numerous products. (51)

Aluminum Extruded Shapes. Aluminum Co. of America, No. AD-229. Explains potentialities of extrusion process for aluminum as money-saver in fabrication operaions. (52)

Aluminum Parts and Forms. Aluminum Goods Mfg. Co., ill, No. A-77. Booklet entitled "Well Prepared to Serve" gives company's facilities for producing aluminum stampings and fabrications. Lists many items being made for current defense effort. (53)

Aluminum Castings. Aluminum Industries, Inc., 4 pp, ill, No. 20.A. Describes this company's facilities offered to industrial plants that need aluminum castings for defense jobs. (54)

Precision Investment Castings. Arwood Precision Casting Corp., 16 pp, ill. Informative article on precision investment castings. Includes table of alloys recommended as most adaptable for this process. (55)

Precision Castings. Atlantic Casting and Engineering Corp., 721 Bloomfield Ave., Clifton, N. J. "Quality Precision Castings for Industry" describes plaster mold casting, its economies and specifications of this firm's alloys. Request direct from Atlantic Casting on company letterhead.

Aluminum Bronze Die Castings. Aurora Metal Co., 8 pp, ill. Description, advantages and sample products of firm's vacuum die casting process. Technical details of alloys used. (56)

Mechanical Tubing. The Babcock & Wilcox Tube Co., 2 pp, No. TB-324. Tells how mechanical tubing can aid in simplifying machining, forming and joining operations. (57)

Steel Tubing. Bundy Tubing Co., 12 pp, ill. Properties, fabricating data, applications and other helpful information for those planning to use copper-coated steel tubing. (58)

Powdered Metal Parts. Chicago Powdered Metal Products Co., 4 pp, ill. Properties and advantages of Camet custom-molded powdered metal parts. Includes design types. (59)

Rolled and Welded Parts. The Cleveland Welding Co., 8 pp, ill. Describes welded circular and rolled steel parts, their advantages in economic and physical aspects, and their applications. (60)

Stainless Steel Castings. Cooper Alloy Foundry Co., 5 pp, ill. Describes in detail methods by which intricate stainless steel castings were turned from problem castings into large scale production jobs. (61)

Sheet Metal Products. Detroit Sheet Metal Works, 3 pp, ill. Describes and illustrates this company's sheet metal working facilities for producing finishing systems, rust proofing and spray washing machines, and industrial heating equipment. (62)

Custom Steel Parts. H. Disston & Sons, Inc., 16 pp, ill. Describes custom steel parts, how they are made, and how to use and order them. (63)

Metal Parts. Dresser Mfg. Div., 13 pp, ill. Folder describes facilities for production of rings, forgings, weldments and other generally circular shapes of various steels and aluminum. (64)

Forged Metal Quality. Drop Forging Assn., 6 pp, ill. Details of several hot working processes emphasizing improvements achieved in metal structure using these processes. (65)

Corrosion Resistant Castings. The Duraloy Co., 16 pp, ill, No. 3150-G. Describes facilities for the manufacture of chromium-iron and chromium-nickel castings. Gives detailed properties of alloys and their uses. (66)

Magnesium and Aluminum Castings. Eclipse-Pioneer Div. Foundries. "Book of Facts" shows company's facilities for custom-making aluminum and magnesium castings. (67)

Die Cast Parts. The Electric Auto-Lite Co., Die Casting Div., 16 pp, ill, No. G137. Describes facilities for economical manufacture of quality die castings. (68)

Metal and Plastics Parts. The Electric Auto-Lite Co., Bay Mfg. Div., 16 pp, ill. Shows wide variety of custom-made ornamental and functional metal and plastics parts. (69)

Steel Castings. Farrell-Cheek Steel Co., 4 pp, ill, No. 40 Examples of the intricate electric furnace carbon and alloy steel castings produced by this company. (70)

Gray Cast Iron. Gray Iron Founders' Society, Inc. Booklet gives mechanical and engineering characteristics of gray cast iron. Includes details for designing cast components. (72)

Investment Castings. Gray-Syracuse, Inc., 4 pp, ill. Various parts of precision-cast brass, bronze, beryllium copper and steel. (73)

Zinc Die Castings. Gries Reproducer Corp., 4 pp, ill. Specifications of corrosion resistant nonferrous zinc alloy wing nuts, small zinc die castings and injection moldings. (74)

Double Headed Parts. John Hassall, Inc. Catalog shows numerous double headed parts, indicating applications and suggesting other applications of double heading operations. (75)

Die Castings. The Hoover Co., Die Castings Div. Describes die castings, gives essential design data including draft, tolerance and wall thickness and core size requirements. (76)

Iron Castings. Hunt-Spiller Mfg. Corp. Comprehensive data useful in design of metal castings on properties and advantages of gun iron and other metals. (77)

Permanent Magnets. Indiana Steel Products Co., 34 pp, *Permanent Magnet Manual* No. 3. Uses, types and materials of permanent magnets. Includes design data. (78)

Beryllium Copper Electrical Parts. Instrument Specialities Co., Inc., 4 pp, ill, Nos. B-52, C-52. Specifications, descriptions and dimensions of beryllium copper grounding strips and contact rings. (79)

Nickel Alloy Steel Castings. International Nickel Co., 32 pp, ill. Discusses advantages and recommended specifications and compositions for typical service applications of nickel containing cast steels. (80)

Investment Castings. Investment Casting Co., 12 pp, ill. "Investment Casting" describes process for precision casting of intricate close tolerance parts in difficult to machine metals, and shows advantages. (81)

Bearing Design. Johnson Bronze Co., Sleeve Bearing Headquarters. Data sheets give information on proper design of bearings, including details such as the lubrication of sleeve type bearings. (82)

Cemented Carbide. Kennametal, Inc., 2 pp, ill, No. 284. Performance reports on high temperature tubing of Kentanium K140A, a cemented titanium carbide. (83)

Stampings. Laminated Shim Co., Stampings Div., 12 pp, ill. Describes facilities for producing good quality stampings to specifications, facts to be considered in ordering stampings, and other data. (84)

Aluminum Extruded Shapes. Light Metals Corp., 6 pp, ill. Shows facilities for producing to order a variety of indicated aluminum fabrications and extruded shapes. (85)

Die Castings. Madison-Kipp Corp., 32 pp, ill. Describes company's aluminum and zinc die castings. Also shows Kipp Feather-Weight air grinder and Fresh Oil lubricators. (86)

Magnesium Parts. Magnesium Products of Milwaukee, 4 pp, ill. Briefly describes facilities for designing and producing to order magnesium and aluminum parts. Shows several products. (87)

Sheet Metal Products. Maysteel Products, Inc., 10 pp, ill. Illustrates Maysteel's standard specialized tools for producing sheet metal parts and shows some of the industries served by their products. (88)

Tungsten Carbide Parts. Metal Carbides Corp., 68 pp, ill, No. 50-G. Descriptions, specifications and prices of standard Talide Metal dies, rolls, bushings, forms and special shapes. (89)

Ferrous and Nonferrous Metal Forms. Metal Goods Corp., 274 pp. Complete stock list and ordering information on metal parts and forms supplied by this company. (90)

Sintered Metal Bearings. Michigan Powdered Metal Products, Inc., 2 pp, ill. Describes sintered metal bearings with cavities in bearing walls to enable greater oil content and heavier bearing loads. (91)

Nonferrous Castings. Monarch Aluminum Mfg. Co., 4 pp, ill. Describes permanent mold castings made by new process to give high, dense finish of great durability. (92)

Plastic-Coated Metal Tubing. Samuel Moore & Co., 2 pp, ill. Entitled "Dekoron In-

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strument Tubing," this bulletin describes advantages of plastic-coated metal tubing and illustrates installations and tubing service data for severe applications. (93)

Seamless Tubing. National Tube Co. Explains time- and cost-cutting fabricating applications of this company's Shelby seamless tubing. (94)

Selecting Springs. Newcomb Spring Corp., 8 pp, ill, No. NS500. "66 Hints to Simplify Design and Reduce Spring Costs" points out ways of specifying lower costs and faster delivery for spring designers and purchasers. (95)

Nonferrous Powder Parts. The New Jersey Zinc Co. "Applications and Properties of Nonferrous Powder Parts" includes 14 case histories indicating cost savings in manufacture of brass powder parts. (96)

Precious Metal Bearings. J. M. Ney Co., 2 pp. Describes the Nobeloy pivot and ball type bearings, which require no oil or adjustment. (97)

Seamless Tubing. The Ohio Seamless Tube Co., 12 pp, ill. Shows differences between such tubing as mechanical seamless, aircraft seamless, resistance welded and forged, listing advantages and applications. (98)

Stainless Steel Castings. The Ohio Steel Foundry Co., 4 pp, ill, No. 651-C. Compositions of Fabrite stainless steels for casting and illustrations of numerous corrosion resistant castings. (99)

Copper Tubing. Penn Brass & Copper Co., 6 pp, ill. Features of this company's seamless copper tubing. Includes tables of safe internal working pressures of various tubing sizes. (100)

Mechanical Steel Tubing. Pittsburgh Tube Co., 44 pp, ill. Detailed information on characteristics, physical properties, fabrication and specifications of this firm's butt welded tubing. (101)

Metal Powders. Plastic Metals Div., 4 pp, ill, No. 567. Describes applications, advantages and limitations of powder metallurgy as used by this firm for custom-making parts. (102)

Welded Mechanical Tubing. Republic Steel Corp., 7 pp, ill. Shows features of new electrical raceway, Electrunite, installation advantages and technical data. (103)

Lockseam Tubes. Revere Copper and Brass, Inc., 36 pp, ill. Contains comprehensive listing of more than 100 shapes of lockseam tube and rolled moldings of interest to manufacturers in the automotive, house furnishings, hardware and farm implement fields. (104)

Rigid Sheet Metals. Rigidized Metals Corp. *Rigidized Metals Idea Handbook* suggests numerous applications for rigid metals with maximum strength-weight ratios. (105)

Industrial Springs. Sandsteel Spring Div., Sandvik Steel, Inc., 10 pp, ill. Informative, nontechnical outline of facilities and type of products engineered and manufactured by Sandsteel. (106)

Spun Metal Parts. Spincraft, Inc., No. 3. Data book on metal spinning and fabricating gives data on process and help in designing for economical production. (107)

Cast-Weld Construction. Steel Founders' Society of America, ill. Outlines numerous examples of leading foundries' application of cast-weld construction to obtain metals savings and production economies. (108)

Tungsten Electrodes. Sylvania Electric Products, Inc., 2 pp, ill, No. TC-1. Advantages, sizes, surface finishes, tempers and packing and distribution of tungsten electrodes for atomic hydrogen, helium and argon arc welding. (109)

Seamless Tubing. Tube Reducing Corp., 16 pp, ill, No. R2. Describes Rockrite process for making metal tubing to close tolerances. Lists advantages and tubing available. (110)

Centrifugal Cast Parts. U. S. Pipe and Foundry Co., 12 pp, ill. Describes centrifugal casting process and advantages, and shows three applications improved by this method. (111)

Metal Powder Machine Parts. The Wel-Met Co., 4 pp, ill. Numerous applications in which powder metallurgy proved a more economical method of producing parts than other methods. (112)

Light Metal Shapes. R. D. Werner Co., 4 pp, ill. Explains relative merits of cold roll forming and extruding light metal shapes. Shows company's facilities for both types of fabrication. (113)

Spun Tubing. Wolverine Tube Div., 28 pp, ill. Advantages and numerous applications of this firm's nonferrous Spun End Tube Process. (114)

Coatings • Finishes

Chromate Coatings. Allied Research Products, Inc., 4 pp, ill. Characteristics of Iridite chromate coatings; said to give good corrosion protection, paint adherence and wide color choice. (115)

Protective Coatings. Houghton Laboratories, Inc., 3 pp, ill. Applications and uses of "Coradon" and "Coradal" metal conditioning systems for abrasion and chemically resistant coatings. (116)

Protective Coating. Maas & Waldstein Co., No. 117. Technical data on Water Dip #33, protective coating for plated metal surfaces said to afford good oxidation protection. (117)

Corrosion Resistant Coating. Merchants Chemical Co., 4 pp. Gives advantages and outstanding properties of this firm's corrosion resistant coatings. (118)

Zinc Dust Paints. New Jersey Zinc Co., 36 pp, ill. Characteristics and uses of zinc dust paints, most adherent paints for galvanized iron and steel zinc. (119)

Industrial Protective Coatings. United Chromium, Inc., 4 pp, ill, No. MC-2. Describes Ucilore industrial coatings for corrosion protection of wood, metal and concrete. (120)

Methods and Equipment

Heat Treating • Heating

Induction Heating. Ajax Electrothermic Corp. Technical bulletins describe induction heating equipment for scale-free heating of steels. (121)

Induction Furnaces. Ajax Engineering Corp. Information on Ajax-Tama-Wyatt induction furnaces for melting metals with accurate temperature control and freedom from contamination. (122)

Case-Hardening Process. American Gas Furnace Co. Principles of "Ni-Carb" case-hardening, its advantages, and descriptions of AGF furnaces for the process. (123)

Controlled Atmosphere Furnace. Dow Furnace Co., 1 p, ill. Describes features of Dow Model G batch-type controlled atmosphere furnace and gives specifications. (124)

Electric Sintering Furnaces. The Electric Furnace Co., 4 pp, ill. Descriptions and uses of nine EF sintering furnaces. (125)

Electric Furnaces. Harper Electric Furnace Corp., 4 pp, ill. Descriptions of various high temperature electric furnaces for special applications and electric tunnel kilns for processing ceramics. (126)

Mold Heating Units. Improved Paper Machinery Corp., Plastic Molding Machinery Div., 1 p, ill. Specifications and descriptions of Models 1 and 2 mold heating and circulating units. (127)

High Frequency Heater. Lewis Machine Co., Inc., 4 pp, ill. Description, specifications and advantages of this company's induction unit for production brazing, hardening and annealing. (128)

Brazing Furnaces. Lindberg Engineering Co., 8 pp, ill, No. 210. Features and advantages of this firm's mesh belt and roller hearth continuous production brazing furnaces. (129)

Induction Heating. The Ohio Crankshaft Co. Describes plant survey and possible applications to which induction heating might be put for greater production economy. (130)

Heat Treating Accessories. Rolock, Inc., 4 pp, ill, No. 949. Describes use of heat and corrosion resistant alloys in baskets, racks, muffles, retorts, trays, etc. (131)

Ammonia Dissociators. Sargeant & Wilbur, Inc., 4 pp, ill, No. A.D. 10. Features, specifications and applications of a variety of this company's ammonia dissociators. (132)

Air Compressors. The Spencer Turbine Co., 12 pp, ill, No. 126-A. Performance curves, capacity tables and detailed descriptions of Turbo Compressors for use in gas- or oil-fired heat treating equipment. (133)

Heat Treating Furnaces. Standard Ameri-

can Engineering Co., 6 pp, ill. Principle of Radivection gas-fired furnaces, indicating advantages in more uniform, faster heating for heat treating purposes. (134)

Heat Treating Accessories. Stanwood Corp., 16 pp, ill, No. 16. Describes variety of heat treating accessories, including baskets, retorts and carburizing boxes. (135)

Heat Treating. Surface Combustion Corp., 7 pp, ill, Vol. 2, No. 2. *Heat Treat Review* gives features and advantages of continuous production with Surface batch furnaces. (136)

Annealing and Cleaning Brass Strip. U. S. Rockwell Co., 4 pp, ill. Describes continuous strip annealing process, an operation involving the preparation of brass strip for the annealing furnace. (137)

Heat Treating Furnaces. Westinghouse Electric Corp., 38 pp, ill. No. B-5459. Entitled "Harnessing Heat," this booklet describes 12 different types of gas and electric furnaces, and briefly outlines their chief field of application. (138)

Cleaning • Finishing

Buffing and Polishing Machine. Acme Mfg. Co. Descriptions and features of this firm's automatic buffing and polishing lathes for rapid finishing of parts in quantity. (139)

Cleaning and Finishing Media. Almco Div., Queen Stove Works, Inc., ill. Features and applications of Supersheen Abrasive Chips and Compounds for barrel finishing and cleaning. Also data on finishing machines. (140)

Hot Dip Galvanizing. American Hot Dip Galvanizers Assn., Inc., 8 pp, ill. Discusses hot dip galvanizing, the problems encountered by galvanizers, and its capabilities. (141)

Grinding and Polishing Stainless Steel. American Nickeloid Co. Gives facilities for custom grinding and polishing stainless steel and describes firm's capacities for handling sheets up to 60 by 144 in. (142)

Cleaning Cabinets. American Wheelabrator and Equipment Corp., 28 pp, ill, No. 724. Describes Wheelabrating cleaning process and equipment used to meet specific requirements of cleaning and finishing problems of various industries. (143)

Spray Painting. Conforming Matrix Corp., 2 pp. Describes features and operation of automatic spray painting machine for decorating plastic and metal parts. (144)

Descaling Process. E. I. du Pont de Nemours & Co. (Inc.), Electro-chemicals Dept., 8 pp, ill, No. A-6506. Describes sodium hydride process for descaling metals, advantages and necessary equipment. (145)

Degreasing Operation. Manufacturers Processing Co., 23 pp, ill. Booklet describes the advantages, applications and methods of vapor degreasing. (146)

Metal Cleaner. Niagara Alkali Co. Pamphlet gives properties of Nialk Trichlorethylene, high quality metal-cleaning and degreasing agent. (147)

Barrel-Finishing. Norton Co., 55 pp, ill. Catalog gives features of Alundum Tumbling Abrasive, barrel-finishing procedure and practical aids to the tumbling room operator. (148)

Cleaning for Plating on Steel. Oakite Products, Inc., 27 pp, No. F5867R1. "Four Good Steps Toward Better Electroplating on Steel" describes four steps especially helpful in obtaining superior cleaning of both low- and high-carbon steel. (149)

Industrial Brushes. Pittsburgh Plate Glass Co., Brush Div., Dept. W-4, 3221 Frederick Ave., Baltimore, Md. Case histories indicate economies available to users of Pittsburgh brushes. Request on company letterhead direct from this company.

Metal Cleaning. Solventol Chemical Products, Inc., 5 pp, ill. Shows washer designs and exclusive features of Solventol spray washers and their uses in defense jobs. (150)

Tumbling Barrels. Tumb-L-Matic, Inc., 2 pp, ill, No. XL-48. Features and specifications of Lupomatic wet process tumbling barrels for deburring and cutting down metal parts. (151)

Hard Chromium Plating Unit. Ward Leonard Electric Co., 4 pp, ill. Features of Model A-20 Chromaster industrial hard chromium plating unit, description of process and Chromasol solution. (152)

Welding • Joining

Riveting Aluminum. Aluminum Co. of America, 64 pp, ill. Comprehensive riveting data include information on design and protection of joints, driving methods and selection of rivet alloy. (153)

Silver Brazing. American Platinum Works, 48 pp, ill. Reference manual on silver brazing discusses low temperature brazing, brazing alloys, design considerations and other topics. (154)

Resistance Welding Electrodes and Alloys. Ampco Metal, Inc., 4 pp, ill, No. RW-2. Describes Ampco's line of resistance spot welding tips, seam and tube welding wheels, and water-cooled holders and connectors. (155)

Rivets. Champion Rivet Co., 48 pp. Specifications of small and large rivets and comprehensive tables of approximate weights. (156)

Bonding Resins. Ciba Co., 4 pp, ill. Properties of new group of resins, their applications as adhesives for metals and nonmetallics, moldings and coatings. (157)

Solder Alloys. Federated Metals Div., 36 pp, ill. Properties of fusible alloys, principles and thermal effects of soldering and applications, descriptions and specifications of this company's solders. (158)

Arc Welding Accessories. General Electric Co., 7 pp, ill, Nos. GEC-865, 866, 867. Three bulletins describe arc welding accessories, list specifications, types and catalog number for each item. (159)

Silver Brazing Alloys. Handy & Harman, 24 pp, ill, No. 20. Information on Easy-Flo and Sil-Fos low temperature silver brazing alloys, and valuable data on brazing methods. (160)

Threaded Inserts. Heli-Coil Corp., 15 pp, ill, No. 650-R. Description, advantages and specifications of Heli-Coil threaded inserts for insertion into tapped holes to protect threads, reduce wear and expense. (161)

Induction Heating for Brazing. Lepel High Frequency Laboratories, Inc., 8 pp, ill. Details on induction heating units for accelerated brazing of parts. (162)

Arc Welding Equipment. Lincoln Electric Co., 2 pp, ill, No. 1304. Gives construction and specifications of engine-driven shield-arc SAE welder. (163)

Designing for Welding. Linde Air Products Co., 20 pp, ill, No. F 7811. Reprints of articles stressing the economies of good welding design. Includes summary of standard welding symbols. (164)

Brazing Rings. Lucas-Milhaupt Engineering Co., ill. Case history shows advantages of patented, notched-coil, stress-relieved silver alloy brazing and soldering rings. (165)

Fastener. New Process Screw Co. Bulletin describes Twin-fast screws for rapid fastening of wood to metals, plastics or other woods. (166)

Self-Locking Fasteners. The Palnut Co., 1 p, ill. Describes self-locking machine screw Palnuts, coil tube fasteners, shield can fasteners and acorn Palnuts. (167)

Welding Positioners. Ransome Machinery Co., Industrial Div., 36 pp, ill, No. 210-C. Description, features and applications of 100- to 40,000-lb capacity welding positioners. (168)

Soldering Aluminum. Reynolds Metals Co., 4 pp, No. 17. Latest techniques and materials developed for soldering and machining aluminum. (169)

Fasteners. Simmons Fastener Corp. Literature describes fasteners especially designed for use in construction where easy demountability is required. (170)

Nut Retainers. Tinnerman Products, Inc., 8 pp, ill, No. 245-3. Specifications and descriptions of Speed Grip nut retainers offering a sure method of keeping nuts secure. (171)

Lock Nuts. Townsend Co., 2 pp, ill. Features and specifications of Tufflok nuts, special nuts with nonmetallic insert on top of nut to provide tight grip. (172)

Weldments. The Van Dorn Iron Works Co., 10 pp, ill. Shows this company's facilities for producing weldments and other parts in all sizes and examples of the type of work produced. (173)

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Forming • Casting • Molding • Machining

Colloidal Graphite. The Acheson Colloids Corp., 5 pp, ill, No. 427. Describes how

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colloidal graphite dispersions are used in the metalworking, glass and rubber industries, and gives details of many specific applications. (174)

Machining Stainless Steels. Armco Steel Corp., 37 pp, ill. Lists grades and their descriptions and characteristics. Also gives operating instructions, tool compositions and selection charts. (175)

Specimen Grinders. Buehler Ltd., 6 pp, ill. Describes grinders and surfacers designed for metallurgical samples. Both belt and wheel types are offered for wet or dry grinding. (176)

Grinding. Carborundum Co., Form A-1204. New revised Series of 32 bulletins, eight entirely new, of this company's grinding tools. (177)

Spiral Milling Attachment. Cincinnati Milling Machine Co., 4 pp, ill, No. M-1715. Features and specifications of milling attachment designed for use in tool and die shops, job shops and production shops. (178)

Band Tools. The Doall Co., 160 pp, ill. Manual presents methods for selecting and operating band tools and machines for sawing, slicing, grinding, filing and polishing all materials. (179)

Electron Arc Drill. Elox Corp. of Michigan, 3 pp, ill. Discusses operation, cost of operation, and gives advantages and specifications. (180)

Chamfering Electrode. Eutectic Welding Alloys Corp., 25 pp, ill. Describes ChamferTrode, new rod for gauging, chamfering and milling operations on all metals and alloys without oxygen or special equipment. (181)

Hydraulic Press Equipment. Hannifin Corp., No. 150. Complete story of how a single compact hydraulic unit can be incorporated in forming equipment. (182)

Casting Riser Compound. Metal & Thermit Corp., 10 pp, ill. Catalog describes Thermit Riser Compound designed to assure sound castings, and gives instructions on its use. (183)

Bending Machine. Struther Wells Div., 4 pp, ill, No. R-1051. Gives features and operation of roller table bending machine designed to handle all types of metal. (184)

Multiple Hole Punching. Wales-Strippit Corp., 8 pp, ill. Features, applications, parts and typical setups of multiple hole punching systems for rapidly punching sheet parts. (185)

Aluminum Extrusion Presses. Watson-Stillman Co., ill, No. 340-A. Describes this company's light metals extrusion presses of 500- to 5,000-ton capacities, their features and advantages. (186)

Adjustable Perforating Dies. S. B. Whistler & Sons, Inc. Catalog describes this company's line of adjustable perforating dies for punching holes in sheet metals. Includes prices and applications. (187)

Tube Mills. The Yoder Co., 65 pp, ill. Pros and cons of operating a tube mill, plus detailed information on the process. Also, technical data on standard and other equipment. (188)

Inspection • Testing • Control

Laboratory Microscopes. Bausch & Lomb Optical Co., 24 pp, ill, No. D-185. Descriptions and specifications of various microscopes for such uses as metallurgical microanalysis. (189)

Metallograph. Bausch & Lomb Optical Co., 20 pp, ill, No. E-232. Features of Balphot metallograph for microscopic examination of metallographic specimens. (190)

Ultrasonic Equipment. The Brush Development Co., 4 pp, ill, No. F-267. Uses and specifications of Hypersonic Equipment for such uses as emulsification, dispersion and degassing. (191)

Hardness Testers. Clark Instrument Inc., 4 pp, ill. Shows features of this firm's hardness testers, and discusses their accuracy, speed of operation and durability. (192)

Industrial Radiography. Eastman Kodak Co., ill, price $3.00. Valuable data on radiographic principles, practice and techniques in modern industry. (193)

Thermocouples. Charles Engelhard, Inc., No. 330-D. Shows features of full line of this company's noble metal thermocouples. (194)

Radiation Detectors. General Electric Co., Apparatus Dept., 7 pp, ill, No. GEA-5735. Contains information on ten nuclear radiation detectors designed for use in industry, hospitals, laboratories and civil defense work. (195)

Metallurgical Laboratory Equipment. Harshaw Chemical Co., Harshaw Scientific Div., 12 pp, ill, No. D2637. Catalog describes and gives specifications of this company's available metallurgical laboratory equipment. (196)

Compression Tester. National Forge and Ordnance Co., 2 pp, ill, No. 492. Description, features and uses of sensitive, sturdy, low-capacity-compression-crust testing machine. (197)

Portable Hardness Tester. Newage International, Inc., No. ET10. Describes Ernst portable hardness tester for direct, accurate readings in Rockwell or Brinell low, medium or high ranges. (198)

Hardness Tester. Peabody Industries, Inc., 2 pp, ill. Briefly describes Metalometer and its advantages in precision testing for the metal working industry. (199)

Temperature Controls. The Pyrometer Instrument Co., No. 150. Catalog shows Pyro Immersion Pyrometer, accurate instrument for nonferrous foundry temperature control. (200)

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Ultrasonic Thickness Gage. Sperry Products, Inc., 4 pp, ill, No. 3700. Description and basic theory of Reflectogage ultrasonic thickness tester and flow detector. (201)

Proving Rings. Steel City Testing Machines, Inc., 2 pp, ill. Description and specifications of direct reading proving rings for calibrating the load on various testing machines. (202)

Temperature and Pressure Controllers. Tagliabue Instruments Div., 3 pp, ill, No. 1320. Gives specifications of TAG self-operating temperature and pressure controllers used in most every kind of industrial plant. (203)

Pyrometer Wire Color Codes. Thermo Electric Co., Inc. Handy chart gives pyrometer color codes, calibration symbols and parts meeting ISA, military and aeronautical specifications. (204)

Package Testing. United States Testing Co., Inc., 8 pp, ill. Describes methods for testing packages designed for products up to 1,000 lb for vibration and impact. Includes prices. (205)

Automatic Recorder. Wheelco Instruments Co., 5 pp, ill, No. C2. Features, advantages and specifications of Capacilog strip chart recorders for testing and control uses. (206)

Radiant Heaters. Edwin L. Wiegand Co., 29 pp, ill, No. FM-2060. Case histories of Chromalox electric radiant heaters with wide assortment of uses. (207)

Hardness Testers. Wilson Mechanical Instrument Co., 44 pp, ill, No. RT-46. Descriptions and features of available Rockwell hardness testers and accessories. Shows operating techniques and principles. (208)

General

Moly-Sulfide Lubricant. Climax Molybdenum Co., 40 pp. Detailed tables of applications of moly-sulfide lubricant in the manufacturing plant, the job shop and in the field, indicating form used and results of application. (209)

High Vacuum Pumps. Distillation Products Industries. Data on high vacuum pumps of unique design for such uses as metal processing and dehydration. (210)

Decimal Equivalent Chart. John Hassall, Inc. Easy-to-read decimal-equivalent wall chart of this company's cold headed parts. (211)

Vacuum Pump. Kinney Mfg. Co., No. V51-B. Information on solving vacuum coating, distillation and dehydration problems. (212)

Casting Reclamation. Tincher Products Co., 24 pp, ill. Covers most frequently asked questions regarding Tincher's process for reclaiming rejects due to porosity in castings. (213)

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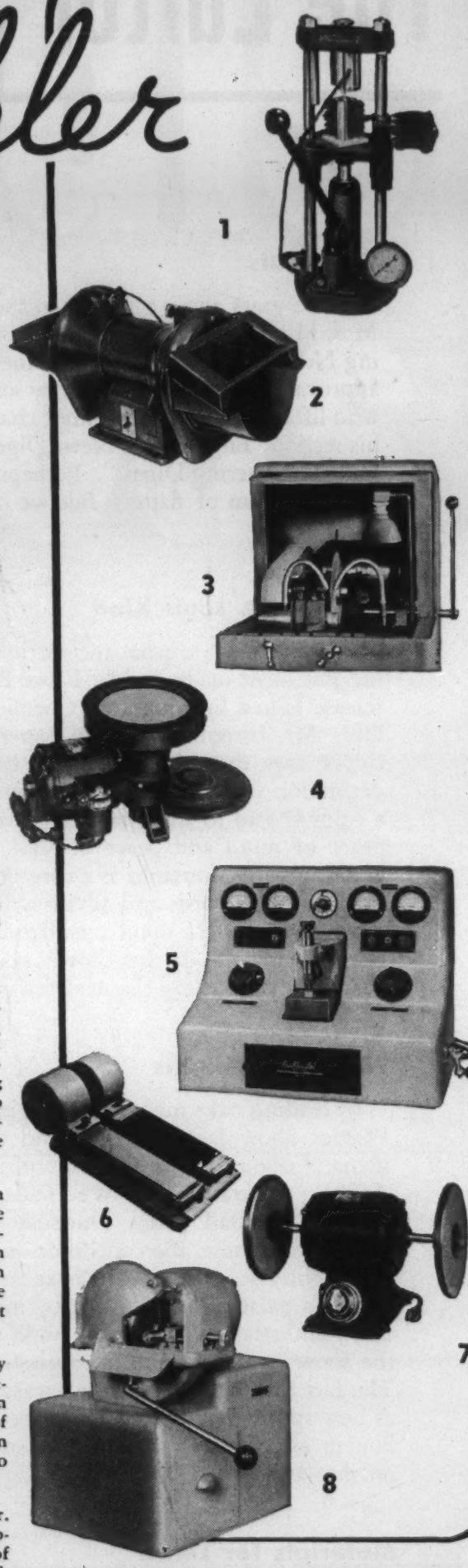
Buehler

Offers a Complete Line of Equipment for the . . . METALLURGICAL LABORATORY



Buehler specimen preparation equipment is designed especially for the metallurgist, and is built with a high degree of precision and accuracy for the fast production of the finest quality of metallurgical specimens.

1. No. 1315 Press for the rapid moulding of specimen mounts, either bakelite or transparent plastic. Heating element can be raised and cooling blocks swung into position without releasing pressure on the mold.

2. No. 1211 Wet power grinder with ¾" hp. ball bearing motor totally enclosed. Has two 12" wheels mounted on metal plates for coarse and medium grinding.

3. No. 1000 Cut-off machine is a heavy duty cutter for stock up to 3½". Powered with a 3 hp. totally enclosed motor with cut-off wheel, 12" x 3/32" x 1-1/4".

4. 1505-2AB Low Speed Polisher complete with 8" balanced bronze polishing disc. Mounted to ¼ hp. ball bearing, two speed motor, with right angle gear reduction for 161 and 246 R.P.M. spindle speeds.

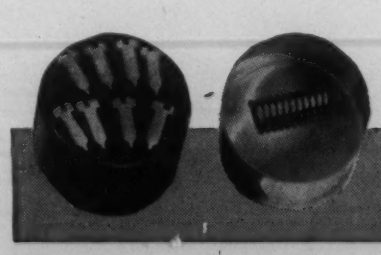
5. No. 1700 New Buehler-Waisman Electro Polisher produces scratch-free specimens in a fraction of the time usually required for polishing. Speed with dependable results is obtained with both ferrous and non-ferrous samples. Simple to operate—does not require an expert technician to produce good specimens.

6. No 1410 Hand Grinder conveniently arranged for two stage grinding with medium and fine emery paper on twin grinding surfaces. A reserve supply of 150 ft. of abrasive paper is contained in rolls and can be quickly drawn into position for use.

7. No. 1400 Emery paper disc grinder. Four grades of abrasive paper are provided for grinding on the four sides of discs, 8" in diameter. Motor 1/3 hp. with two speeds, 575 and 1150 R.P.M.

8. No. 1015 Cut-off machine for table mounting with separate unit recirculating cooling system No. 1016. Motor 1 hp. with capacity for cutting 1" stock.

The Buehler Line of Specimen Preparation Equipment includes . . . Cut-off Machines • Specimen Mount Presses • Power Grinders • Emery Paper Grinders • Hand Grinders • Belt Surfacers • Mechanical and Electro Polishers • Polishing Cloths • Polishing Abrasives.



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METALLURGICAL APPARATUS
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The Editor's Page

Copy Cats

Some years ago we started in the front pages of M & M a news section called "Materials Engineering News Digest". Apparently the name met with approval. At least it was liked by some rival editors, who lifted the label with minor changes. One calls his section "Engineering News Digest" and another just "Engineering Digest". Perhaps imitation is the sincerest form of flattery, but we can't be sure we like it.

Not the St. Louis Kind

"More blues are what the world needs today" is the statement made by Mr. Faber Birren in a news release issued by Monsanto Chemical Co., Plastics Div. Mr. Birren, who is an expert in the use of colors, says that blues are to be the fad in home decoration for the next four or five years. Blue as a color is said to stand for confidence, equanimity, peace of mind and peace of soul. Mr. Birren is working with Monsanto as a consultant to the Plastics Div. His words and advice will probably have considerable effect upon merchandise—both plastics and metals—to be shown you and possibly shown by you during the next few years.

Plastics Highlights

In reading over my notes of highlights from the Plastics Show last month, I find these unrelated items: Cocktail party, Tuesday; plastics cars; Miss Anchor; cocktail party, Wednesday night; Betty Furness; cocktail party, Thursday night; plastics pipe. From these, the conclusion might be drawn, and rightly so, that sales messages are now being made as palatable as possible by means of Misses and Manhattans. As far as I could see, the hits of the show were two reinforced-plastics auto bodies. The fact that they were plastics wasn't as important as how sporty they looked. It seemed that the playboy in all of us warmed to the snappy roadsters on display.

Materials for Lunch

Recently we completed an article on the Materials Engineering Dept. of Westinghouse. Soon thereafter came a release from the company's Public Relations Dept., which seemed to indicate that considerable materials engineering went into the outfitting of the East Pittsburgh plant's new cafeteria. For example, the cafeteria has a stainless steel dishwasher and Micarta topped tables. However, the acme is achieved in describing the utensils, which include coral plastics plates, anodized aluminum trays, and stainless steel flatware.

Needed: A Definition

From time to time when watching a pleasant television program called "What's My Line", I'm startled by a question that recurs. The question is: "Is the product you are identified with made of material?" The fact that everything is made of material seems to escape panelists on the program. To them material means cloth. Therefore, it would seem that either a new definition for material be developed or further education on current definitions be advocated. Since we seldom talk about cloth, we hate to see those materials we are interested in dealt with so shoddily.

There's Life in the Old Society

We don't know whether scientists writing reports for technical society meetings are becoming more imaginative, or if the public relations boys are having a field day. At any rate, we were leafing through the abstracts of a recent ASM meeting the other day, and had our stupor suddenly shattered by some opening paragraphs which made us think of the Sunday Supplement.

Here are some examples: "To be a metallurgist, don't be color-blind." "Next thing you know, metals will have to roll over and jump through hoops to maintain their health." "'Pickle lag' a phenomenon in the metallurgy of tinplate should interest every housewife." "Atoms of metal must be conducting a merry dance. At least they appear to be indulging in perpetual wrestling matches among themselves."

We are not necessarily condemning the use of such colorful writing, but the shock still leaves us trembling. It has been said that just because it is technical writing, it doesn't have to be dull. With that we agree.

T. C. Du Mond
Editor